



Concise Textbook *of* Forensic Medicine *&* Toxicology

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Edition

R. K. Sharma



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CONCISE TEXTBOOK OF
FORENSIC MEDICINE AND TOXICOLOGY
Third Edition



CONCISE TEXTBOOK OF
FORENSIC MEDICINE AND TOXICOLOGY
Third Edition

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Concise Textbook of Forensic Medicine and Toxicology, 3/e
RK Sharma

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Medical knowledge is constantly changing. As new information becomes available, changes in treatment, procedures, equipment and the use of drugs become necessary. The authors, editors, contributors and the publisher have, as far as it is possible, taken care to ensure that the information given in this text is accurate and up-to-date. However, readers are strongly advised to confirm that the information, especially with regard to drug dose/usage, complies with current legislation and standards of practice.

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To
All departed souls
on whose bodies we learnt Forensic Medicine



Preface to the Third Edition

I am happy that undergraduate students of Forensic Medicine and Toxicology have immensely appreciated the second edition of this book. The medical fraternity teaching Forensic Medicine and Toxicology has also welcomed the second edition of the book. Both students and teachers generously sent their comments/suggestions for improving the book. So, I felt the need to thoroughly revise the book in light of their comments and suggestions. The third edition of the book is thus in your hands.

We are aware that medical knowledge is evolving rapidly, hence some parts of the book needed to be revised and updated incorporating recent developments. A new chapter, Recent Advances in Crime Detection featuring new concepts like lie detector test, narco-analysis, brain mapping, and hypnosis and voice stress test has been added. The section on the techniques of collecting samples for DNA fingerprinting in living and dead cases as also the chapters, Insanity and Forensic Psychiatry and Sexual Offences have been thoroughly revised and updated. More photographs have been added and new tables have been inserted in some chapters with the understanding that these would facilitate comprehension of critical concepts and enhance retention of information. It is hoped that this endeavour would help the students to perform better in examinations. A new appendix on toxic agents has been included which would be useful in the study of toxicology.

I sincerely thank all my students and colleagues for their frank comments to enhance the value of the book. I am aware that perfection cannot be achieved in one or two attempts, it requires more efforts. I, therefore, request my students and colleagues to continue sending their comments and suggestions just as they did for this edition.

I hope the book would serve the purpose of students more effectively now.

New Delhi

R.K. SHARMA



Preface to the First Edition

During my undergraduate days, I felt the lack of a good short textbook of forensic medicine which would be useful in revising the curriculum at quicker pace at the time of examinations, as we were burdened with other subjects too. When I joined as a faculty member, I saw my students facing the same problem. To overcome this problem, the idea of writing the present book took shape in my mind.

This book has been written keeping in view needs of undergraduate students and it covers the whole curriculum as prescribed by Medical Council of India. I hope it would also be useful for students pursuing carrers in a ayurvedic, homoeopathic, unani and siddha systems of medicine. This book contains 40 chapters which are based on the lecture schedule as followed in most of the medical colleges. New concepts like cloning, euthanasia, date rape, DNA fingerprinting have also been added. Toxicology has been revised according to latest clinical practice.

Critical comments and suggestions to improve this book are welcome from all, especially students and residents.

I would thank my childhood friends Umashanker Sharma, Ved Prakash Jindal, Dr. Vinod Kumar Jain and Harprit Singh for their moral support. My departmental colleagues especially Dr. D.N. Bhardwaj, Additional Professor and Dr. Sudhir Kumar Gupta, Assistant Professor who are more of friends have encouraged me at all levels to complete this work.

I would like to thank the Elsevier team especially Mr. Rajiv Banerji, Tanweer Ahmad, Ritesh Bhutani.

Last, but not the least, my grateful thanks and appreciation to my family which suffered silently while I was physically and mentally preoccupied with the book for two years.

New Delhi

R.K. SHARMA



Contents

<i>Preface to the Third Edition</i>	vii
<i>Preface to the First Edition</i>	ix

Section 1: FORENSIC MEDICINE

1. Definition and History of Forensic Medicine	3
2. Legal Procedures	5
3. Identification	11
4. Post-mortem Examination	22
5. Examination of Decomposed and Mutilated Bodies, Skeletal Remains, and Exhumation	28
6. Examination of Biological Stains and Hair	32
7. Medico-legal Aspects of Death	38
8. Post-mortem Artefacts	52
9. Asphyxial Deaths	54
10. Death from Starvation, Cold and Heat	65
11. Injuries from Burns, Scalds, Lightning and Electricity	69
12. Injuries by Mechanical Violence	76
13. Fire-arm Injuries	81
14. Medico-legal Aspects of Wounds	92
15. Regional Injuries	103
16. Traffic Injuries	109
17. Impotence, Sterility and Artificial Insemination	111
18. Virginity, Pregnancy and Delivery	117
19. Sexual Offences	124
20. Legitimacy and Medico-legal Aspects of Marriage Annulment	135
21. Infanticide	138
22. Abortion and Medical Termination of Pregnancy	144
23. Insanity and Forensic Psychiatry	150
24. Miscellaneous Topics	162
25. Law in Relation to Medical Practice: Part I	178
26. Law in Relation to Medical Practice: Part II	216
27. Recent Advances in Crime Detection	222
<i>Forensic Slides</i>	

Section 2: TOXICOLOGY

28. Medico-legal Aspects of Poisons	229
29. Corrosive Poisoning	237
30. Irritant Poisons—Vegetable Poisons	245
31. Irritant Poisons—Non-metallic Poisons (Inorganic)	252
32. Irritant Poisons—Metallic Poisons (Inorganic)	259
33. Irritant Poisons—Animal Poisons	275
34. Irritant Poisons—Mechanical Poisons	283
35. Neurotic Poisons—Somniferous Poisons	285
36. Cerebral Poisons—Inebriant Poisons	289
37. Cerebral Poisons—Deliriant Poisons	299
38. Spinal Poisons	306
39. Cardiac Poisons	310
40. Asphyxiants (Irrespirable Gases)	317
41. Food Poisoning	322

APPENDICES

<i>Common Features of Some Toxic Agents</i>	329
<i>Relevant Sections of Law for Medical Practice</i>	332



Section 1

FORENSIC MEDICINE





Definition and History of Forensic Medicine

DEFINITIONS

The specialty of Forensic Medicine is known by various names like Forensic Medicine, Legal Medicine, Medical Jurisprudence and State Medicine, etc. Although all the names carry different meanings they are related to each other.

The word “Forensic” means “of court of law”. Forensic Medicine is defined as application of medical knowledge in the administration of justice.

Medical Jurisprudence deals with the legal aspects of medical practice and knowledge. It brings doctors in contact with laws.

State Medicine is application of medical knowledge in prevention of diseases. It defines the duty of a doctor in relation to notification of all births, deaths, notifiable diseases and food poisoning. It deals with the legal mandatory duties of medical practitioners and personnel.

HISTORY OF FORENSIC MEDICINE

The history of Forensic Medicine is quite old. Documents related to medico-legal work have been found dating back to 4000–3999 B.C. in Egypt, Sumer, Babylon, India and China. A document dated around 3000 B.C. has been found in China that describes poison. Imhotep (2730–2900 B.C.) is considered as the first medico-legal expert. He was the personal physician and Chief Justice to the

King of Egypt. Some of the important landmarks in this context are as follows:

1. **Code of Hammurabi of Babylon (2000–1000 B.C.)** is the oldest medico-legal code given by King of Babylon in 2200 B.C. It describes punishment for medical practitioners in case of improper treatment.
2. **Code of the Hittite (1400 B.C.)** describes compensation for personal injuries sustained.
3. **Roman Law (451 B.C.)** contained a lot of provisions related to medico-legal matters.
4. **Hippocrates (460–377 B.C.)** described lethality of wounds, medical ethics, sudden deaths, etc.

Around the beginning of the Christian Era, many public laws relating to public health, sexual matters and eugenics were made in India which are popularly known as laws of Manu.

5. **Justinian Code (A.D. 529–564)** described penalties for medical practice and principles of regulation of medical profession.
6. **The Barbarian Statute** described the role of medical experts in evaluating injuries.

The first Medico-legal autopsy was conducted by Bartolomeo De Varignana in A.D. 1302 in Bologna, Italy. Guidelines on how to conduct investigations into the cause of death was prepared in China in thirteenth century. In sixteenth century,

the Penal Code of the Bishop of Bamberg and the Caroline Code emphasised on the role of medical evidence in court trials. The famous book on Medico-legal questions, *Questiones Medico-legales*, was written by Paolo Zacchia in 1621 in seven volumes. He was the principal physician to Pope Innocent X and Alexander VII.

Towards the end of the sixteenth century, medico-legal autopsies started becoming frequent at various places around the world. The first book on Forensic Medicine was written in 1602 by Fortunato Feedele, an Italian physician. Famous works on medico-legal scenario by Zacchia was published in seventeenth century. In eighteenth century, professorship in legal medicine was created in Germany. Orfila (1737–1853) was the professor of chemistry and legal medicine in Paris and is regarded as the founder of modern toxicology.

FORENSIC MEDICINE IN INDIA

Manusmriti (3102 B.C.) is the first treatise on various laws written by King Manu. It prescribed code of conduct for society and had many medico-legal laws about marriage, punishment for rape, adultery, etc.

Vedas (2000–1000 B.C.), especially *Atharvaveda*, furnish details about how to cure wounds, poisoning and snake bites. The first Indian book on medicine, *Agnivesha Charaka Samhita* was written by the famous physician Charaka. It describes training, duties, privileges and social status of physicians. It is considered as Indian code

of medical ethics. *Sushruta Samhita* written by Sushruta in 200–300 A.D. refers to poisons, snake signs and treatment of poisoning. Sushruta is considered to be the Father of Indian surgery. Unani system of medicine was introduced in India by Mughal rulers when Ayurveda was flourishing in India. Coroner's Act 1811 was introduced by British in Kolkata and Mumbai and police investigations began in India then. The first chair of professor of Medical Jurisprudence was established in 1857 at Madras Medical College.

The Indian Penal Code (I.P.C.) came into existence in 1860 and Criminal Procedure Code in 1861. The Indian Medical Council Act came in 1933 and established the Medical Council of India at New Delhi.

The most outstanding contribution in medico-legal field in India was made to modern dactylography. Sir William Herschel of the Indian Civil Service in 1858 used dactylography as a method of identification, which was later improved by Sir Francis Galton.

The modern Forensic Medicine in India was started by Dr Jaising P. Modi. For the first time in India in 1920, he was the one who wrote a book on Forensic Medicine and toxicology. It was titled, *Medical Jurisprudence and Toxicology*. He is called the Father of Forensic Medicine in India. He described the Indian medico-legal experience for the first time in his book. In the last fifty years, the specialty of Forensic Medicine has grown all over India and is a part of curriculum in all medical schools. Now, various organisations are working in this field for improvement of the specialty.

Legal Procedures

INQUEST

Inquest means 'to seek'. It is an enquiry into the cause of death. It is conducted where there is suspicion regarding cause of death or cause of death is to be ascertained. There are four types of inquests:

1. Police Inquest
2. Coroner Inquest
3. Magistrate Inquest
4. Medical Examiner system

Police Inquest

It is held all over India and conducted by a competent and authorised police officials. The inquest is held under Section 174 of Cr. P.C. The police officer who conducts this is called an Investigating Officer. The police receives information from village *chowkidars* (guards), public informers, hospitals, and various agencies. On receipt of information about the crime, it is noted in a daily diary register. This entry is commonly called a Daily diary (DD) entry. Once the DD entry is made, an investigating Officer is deputed on the scene of crime to conduct inquest. The Investigating Officer reaches the scene of the crime and takes the stock of the situation. If a person is injured or needs medical assistance, he is rushed to the hospital. If the victim is dead, the Investigating Officer seals the scene of crime and if needed sends requisition for a photographer, fingerprint experts, ballistic experts, etc. to collect

evidence. He prepares a detailed report called *panchnama* in presence of public witnesses (*panchas*) who had some knowledge of the crime. This *panchnama* is called inquest papers. He then forwards the dead body to the medico-legal expert for a post-mortem examination. On reaching the police station, a first information report (FIR) is lodged by him under relevant sections of the Indian Penal Code and investigation into the circumstances of the crime begins.

Coroner's Inquest

Previously, it was held in Mumbai and Kolkata under Coroner Act of 1871. It was first abolished in Calcutta, later in Mumbai. It is of historical value in India but coroner's inquest is still prevalent in many parts of the world. The coroner's inquest is held in following cases:

1. Sudden death where cause of death is not known.
2. Suicide, homicide and infanticide.
3. Accidental death, poisoning, traffic accidents, drug mishap, industrial accidents.
4. Death occurring while in treatment like under anaesthesia.
5. Custodial deaths like death in prison, police station, mental asylum, etc.

The coroner used to be of the rank of a First Class Magistrate. He had the powers to order a post-mortem and exhumation. He had the power to summon a doctor to depose in his court. He had

the powers to summon witnesses and record statements and if he suspected foul play he used to give a verdict of foul play and then assign the case to the concerned magistrate for trial. When the accused was not found he used to return an open verdict which means that the inquest was postponed indefinitely and could be opened on receipt of new information. In a coroner's court, the presence of the accused was not essential.

Magistrate Inquests

It is held under Section 176 Cr. P.C. and is conducted by an executive magistrate like Subdivisional or District magistrate. It is considered to be superior to police inquest. It is held in following cases:

1. Death in prison
2. Death in police custody
3. Death due to police firing
4. Dowry deaths under Sec. 304B of the Indian Penal Code
5. Any case where the government orders that inquest needs to be conducted by a magistrate.

Magistrate can order exhumation. Earlier, a coroner also had the power to order exhumation. In any case of death, magistrate can hold inquest even if the police has already made the inquest.

Medical Examiner System

This system is prevalent in the United States of America where a forensic pathologist is appointed as a medical examiner. He conducts the post-mortem and usually visits the scene of crime. Being a doctor, he is able to easily correlate injuries with circumstances. He submits his report to the district attorney for further action. This system is considered superior to a police inquest.

DIFFICULTIES IN DETECTION OF CRIME IN INDIA

The following are the difficulties which are commonly faced in detecting crime in India:

1. **The Delay in Information:** Police is unable to act on time as information regarding crime reaches the police quite late due to lack of communication facilities like telephones, etc., especially in villages or remote areas.
2. **Decomposition:** As police reaches late, the signs of decomposition may have already set in and vital evidence may be lost.
3. **Lack of Medical Knowledge:** As majority of police officials are ignorant about medical knowledge, they experience difficulty in correlating injuries with circumstances.
4. **Rapid Disposal of Dead Bodies:** As per religious customs, cremation is done in Hindu and Sikh communities, if the body is cremated before arrival of police, vital evidence may be lost. Even in cases of burial, rapid decomposition may cause loss of evidence as the permission for exhumation may take some time.

COURTS IN INDIA

As doctors have to appear in various courts of law, it is better for them to get familiar with different courts in India and their powers (Table 2.1). There are two types of courts in India: (1) civil and (2) criminal.

The courts in India are of four types:

1. **The Supreme Court:** It is located in New Delhi, and is the highest judicial tribunal in India. It can pass any sentence prescribed by the law and supervises all the courts in India. The law declared by it is binding on all courts.
2. **The High Court:** It is usually located in the capital of every State, and is the highest tribunal of the state. It can try any offence and pass any sentence prescribed by the law.
3. **The Sessions Court:** It is located at district headquarters, and can pass any sentence authorised by the law but the death sentence passed by it must be confirmed by the High court.

4. **The Magistrate Courts:** The magistrate courts are of following types:

- (a) Chief Judicial Magistrate or Chief Metropolitan Magistrate can pass imprisonment for up to 7 years, and can also impose fine without limit. He can order solitary confinement as well.
- (b) First Class Magistrate or Metropolitan Magistrate can pass a maximum of 3 years sentence, fine up to Rs. 5000/- and can also order solitary confinement.
- (c) Second Class Magistrate can sentence up to one year, and fine up to Rs. 1000/-. Also, he can order solitary confinement.

Cognisable Offences

It is an offence where a police officer can arrest a person without a warrant from the magistrate, e.g. rape, murder, grievous hurt, etc.

The sentences authorised by law are: (a) death, (b) imprisonment for life, (c) rigorous imprisonment, and/or solitary confinement, (d) simple imprisonment, (e) forfeiture of property, (f) fine, and (g) detention for treatment, training and rehabilitation of young offenders under the age of 16 years.

Subpoena or Summons (*Sub* means under, *poena* means penalty)

It is a document issued by the court commanding the attendance of the witness to appear in the court

under penalty threat on a specified day, time and place for giving evidence. It may also ask him to produce any book, document or case records supposedly under his control for the inspection by the court. The witness can be excused from attending the court only if he has some valid and urgent reasons.

Noncompliance of summon may render a person to pay damages in a civil case, or pay fine or sustain imprisonment in criminal cases. Criminal courts have priority over civil courts. If a person has received two summons for the same day, one of which is from a criminal court and the other from the civil, he should attend the criminal court and should inform the civil court. Higher courts have priority over the lower courts. If summoned to two courts, both civil and criminal, he should first attend the higher court. If he is summoned by two courts of the same status he should attend the court from where he has received the summons first, informing the other court.

Conduct Money

In civil cases, a reasonable sum that would be incurred as travelling expenses is usually tendered at the time of serving of summons. This is known as 'conduct money'. It is paid by the party who has called him to give evidence. If the fee is not paid, doctor can ignore the summon or, if he feels it is insufficient, he can bring it to the notice of the court which will decide whether it is reasonable or not. If the court feels it is insufficient, it may direct the party who has called the doctor to give evidence or

Table 2.1 Powers of different courts

<i>Court</i>	<i>Death sentence</i>	<i>Imprisonment</i>	<i>Fine</i>
1. Magistrate Court			
(a) Second Class Magistrate	No	One year	Rs. 1000/-
(b) First Class Magistrate	No	Three years	Rs 5000/-
(c) Chief Judicial Magistrate	No	Seven years	No limit
2. Sessions Court	Yes (but to be confirmed by High Court)	Life sentence	No limit
3. High Court	Yes	Life sentence	No limit
4. Supreme Court	Yes	Life sentence	No limit

to pay more. In criminal cases, no fee is paid at the time of serving summons. However, usually the court gives travelling charges and daily allowance after the doctor has deposed in the court.

COURT PROCEDURE

The evidence of the witness is recorded as follows:

1. Oath
2. Examination-in-chief
3. Cross-examination
4. Re-examination
5. Questions put by the judge

Oath

Before starting the procedure, witness has to take an oath. The format is: "I swear by God that I shall speak truth, the whole truth and nothing else but truth." If the witness is an atheist, he has to make solemn affirmation instead of swearing by God.

Examination-in-Chief

The first examination is done by the counsel who has called the witness to the box. In this examination, no leading questions can be asked. A leading question is defined as the question, which suggests some answer, e.g. "whether on the day of murder you were wearing a red shirt or not?" The purpose of the examination-in-chief is to place on record, all the information the witness has about the case. In case of medical witness it is the public prosecutor who examines him first.

Cross-examination

It is considered to be the most reliable procedure of testing the value of an evidence and is held by the counsel for the accused, or the opposite party. The witness may be asked any question including the leading question. There is no time limit fixed for cross examination.

However, the court reserves its right to disallow any question it deems unnecessary or insulting to the witness.

Re-examination

The counsel who has first conducted examination-in-chief, has the right to re-examine the witness with the aim to explain any ambiguities, to correct any mistake the witness has made during cross-examination. But the witness should not introduce any new fact without the consent of the judge or the opposing counsel, lest he would be liable to cross-examination.

Questions Put by the Judge

The judge may ask any question at any stage to clear its doubts.

PERJURY

Perjury means willful utterance of falsehood by a witness under oath. He is liable to be prosecuted for the same.

Medical Evidence

It is of two types:

1. Written or documentary evidence
2. Oral evidence.

Documentary Evidence

This refers to all documents produced for the inspection of court, e.g. (a) medical certificate, (b) medico-legal report, and (c) dying declaration.

Medical Certificate: It refers to ill health, insanity, birth and death. It has to be signed by a registered medical practitioner. In giving certificate of ill health, the doctor should mention the exact nature of the illness, and take the signature (preferably) or thumb impression of the patient.

From April 1, 1969, under the Registration of Births and Deaths Act, the registration of births and deaths is compulsory. It is obligatory for a medical practitioner who has attended the last illness of the deceased person to issue a death certificate. The medical practitioner is not entitled to charge any fees for issuing a death certificate.

Table 2.2 Differences between dying declaration and dying deposition

	<i>Dying declaration</i>	<i>Dying deposition</i>
1. Recorded by	Anyone	Only magistrate
2. Oath	Not necessary	Necessary
3. Presence of the accused	Not essential	Accused/lawyer is allowed
4. Cross-examination	Not allowed	Allowed
5. Value	Less value as compared to dying deposition	More value as compared to dying declaration

Medico-legal Reports: These documents are prepared by the doctor on the request of police or investigating agencies in criminal cases like assault, rape, murder, poisoning, etc. The reports consist of two parts: (a) facts observed on examination, and (b) opinion drawn from the facts. The report is not admitted unless the doctor testifies in the court. Exhibits like clothing, weapon, etc. sent for examination should be described in detail after examination and should be handed over after it is properly sealed.

Dying Declaration: It is a statement, written or verbal, of a person who is dying as a result of some unlawful act, relating to facts of cause of his death or any of the circumstances resulting in death.

If there is time, a magistrate should be called. If there is an emergency, the doctor himself should record the statement. But before recording, he should certify that the person is *compose mentis*, i.e. he is conscious and his mental faculties are normal. The statement can be recorded by police or any other person. The statement should be noted down in the man's own words without any alteration. Leading question should be read over to the person and his signature or thumb impression should be taken at the end. If the person is able to give only partial statement, and then he becomes unconscious, only the partial statement should be recorded. The dying declaration is admissible in court as evidence even if the person was not under expectation of death at that time. It is accepted as evidence at the time of trial if the person dies. If the declarant survives, the declaration is not admitted and the person is called to provide oral evidence (Table 2.2).

Dying Deposition: It is the statement of a person on oath before a magistrate, in the presence of the accused or his counsel, who in turn, is allowed to cross-examine the witness. The doctor should first certify whether the person is capable of making a statement or not (*compose mentis*). It means court by the bedside, and has greater value as compared to dying declaration (Table 2.2).

Oral Evidence

It includes all statements made before the Court, by the witness, in relation to the matter under investigation. The oral evidence must be direct. Oral evidence is much more important than documentary evidence as it allows cross-examination. Documentary evidence is accepted by the court only on oral evidence by the person concerned. The following are the exceptions:

1. Dying declaration
2. Expert opinion expressed in a treatise may be proved in court by producing such a book, if the author is dead or cannot be found or called witness without unreasonable delay or expenses.
3. Evidence of doctor recorded in a lower court is admissible in a higher court, provided it was recorded by a magistrate in the presence of the accused.
4. Evidence given by a witness in a previous judicial proceeding, is admissible in subsequent judicial proceedings when the witness is dead or cannot be found, or is incapable of giving evidence, or cannot be called without undue delay or unreasonable expense.

5. Evidence of mint officer.
6. Reports of certain government scientific experts like: (i) Chemical Examiner, (ii) Chief Inspector of Explosives, (iii) Director, Fingerprint bureau, (iv) Director, Haffkine Institute, Mumbai, (v) Director, Central Forensic Science Laboratories, and (vi) the serologist, can be asked for. The court has power to summon and examine these experts.
7. Public records: Routine entries, operative notes, discharge summaries are admissible without oral evidence. But the cause of disease/death is not accepted without oral testimony.

TYPES OF WITNESS

Witness is of two types:

1. Common witness
2. Expert witness

Common Witness

He is the person who gives evidence about the facts within his knowledge and perception. He states what he has actually observed. He provides a first hand knowledge.

Expert Witness

He is the person who has been trained or is skilled in a technical or scientific subject, and is capable of inferring opinion from the facts observed by him as a doctor, fingerprint expert, etc.

A doctor can be both, a common and an expert witness. When he describes the injuries on the body he becomes a common witness. But when he tells how the injuries may have been produced he acts like an expert witness. *Hostile witness* is the one who gives false evidence because of some interest or motive or by concealing the truth.

CONDUCT AND DUTIES OF A DOCTOR IN THE WITNESS BOX

The following are general principles a doctor should observe while giving evidence:

1. He must attend court punctually and produce all the documents asked for. His dress should be consistent with his dignity.
2. He should be well prepared with the details of the case, anticipate likely questions, study the literature and stand up straight.
3. He should never attempt to memorise. He should speak slowly and distinctly with confidence. He should address the judge as "Sir" or "Your Honour."
4. He should use simple language, avoid superlatives and exaggeration. He should not fumble while reporting for records or literature. Avoid discrepancy between record and testimony.
5. The doctor should be pleasant and polite to the counsel or the accused. He should not try to evade a question and should not lose his temper.
6. He should retain independence of his mind. He should be honest, impartial and truthful.
7. He should avoid long discussions. Express an opinion from his own knowledge and experience.
8. Text books of repute can be offered in evidence. Before answering, he should read out the complete passage, as the lawyer might have read only the statements that favour him.
9. A medical man does not have the professional privilege and therefore, must answer all questions.
10. The doctor should volunteer information if he thinks injustice would result if he does not make a statement. The response should not exceed beyond the expert's knowledge.

Identification

Identification is recognition of a person based on certain characteristics which may be (a) complete, i.e. exact fixation of personality, and (b) incomplete like determination of age, sex, race, stature, etc. The doctor is called upon to establish the identity of a dead body or a person brought to him. Identification of a living person is required in criminal cases like, absconding soldiers, person accused of assault, murder, rape, interchange of newborn babies, disputed paternity, etc. and in case of impersonation. In civil cases, identity of a living person is required in cases like marriage, inheritance, disputed sex, etc. The identification of dead bodies is required in cases of sudden and unexpected deaths, fire explosions, railway or aircraft accidents. At least two identification marks should be noted by the doctor and mentioned in all medico-legal reports.

THE CORPUS DELICTI

The corpus delicti means body of offense or essence of crime. In case of a murder, it is the fact that a person has died from unlawful violence and includes the body of the victim and other facts like bullet, knife or clothing.

The following points are usually seen for the purpose of identification:

1. Race
2. Sex
3. Age
4. Complexion and features
5. Hair

6. Anthropometry
7. Dactylography and footprints
8. Deformities
9. Scars
10. Tattoo marks
11. Occupation marks
12. Handwriting
13. Miscellaneous methods of identification such as:
 - (a) Clothes and personal articles
 - (b) Speech and voice
 - (c) Gait
 - (d) Ticks, manners and habit
 - (e) Mental power, memory and education.

Race

It can be determined by following characteristics:

1. **Complexion:** The skin is brown in Indians, fair in Europeans and black in Negroes. It is of limited value.
2. **Eyes:** Indians have dark eyes, Europeans have blue or grey eyes.
3. **Hair:** Indians have black, thin hair; Europeans have fair or light brown or reddish hair. Indians, Mongolians and Europeans have straight or wavy hair while Negroes have woolly hair (arranged in spirals). Mongolian hair is coarse and dark and usually circular on cross-examination and has dense uniform pigmentation and dark medulla. Negro hair is elongated, oval on cross-section and has dense pigment with an irregular distribution.

Table 3.1 Cephalic index in relation to different skulls and races

Types of skull	Cephalic index	Race
1. Dolicho-cephalic (long headed)	70–75	Pure Aryans, aborigine Negroes
2. Mesati-cephalic (medium headed)	75–80	Europeans and Chinese
3. Brachy-cephalic (short headed)	80–85	Mongols

Caucasian hair has oval shape in cross-section with uniform distribution of fine or coarse pigment.

4. **Skeleton:** The cephalic index or index of breadth of skull is very important:

$$\text{Cephalic index} = \frac{\text{Maximum breadth of skull}}{\text{Maximum length of skull}} \times 100$$

The measurements are made with callipers (Table 3.1). Characteristics of Hindu males are that they are not circumcised, sacred thread, necklace of wooden beads (*Rudraksh*), caste marks on forehead, tuft of hair on head and pierced ear lobes. The Hindu females may have vermilion on scalp, silver toe ornaments, tattoo marks, nose ring aperture in left nostril, few openings for ear rings along the helix. Muslim females may have nose ring aperture in septum only, several openings in ears along the helix. All Muslim males are circumcised.

Sex

Sex of individual can be determined either by clinical method or investigations.

Clinical Method

It is by observing secondary sexual characters of the individual. In males, presence of a well-developed penis and testes, hair on upper lip, chin, chest, pinna, pubic hair extending towards naval, underdeveloped breasts and lesser thyroid angle (about 90°) are main characteristics for identification. In females, a well-developed vagina along with labia major and minor with clitoris, well-developed breasts, greater thyroid angle (about 120°), pubic hair being horizontal covering only mons pubis, are the few features which help in identification of the females. But these

characteristics become prominent only after puberty.

The difficulty arises when there is ambiguity of external genitalia and the secondary sexual characters are unable to confirm the sex.

Investigations

There are investigations for sex determination which are as follows:

1. **Sex Chromatin Study:** The Barr body is present in females and absent in males. It can be easily demonstrated in buccal smear. The chromosome in the males is fluorescent to quinacrine and can be demonstrated easily. The determination of sex is quite important in connection with inheritance, marriage, divorce, sexual offenses, participation in sports, etc.

Intersex: It is intermingling of one sex into another. It can be divided into two categories:

- (a) **Gonadal agenesis:** In this condition the testes or ovaries have never been developed. The nuclear sex test is negative. It is quite rare.
- (b) **Gonadal dysgenesis:** It is mainly of four types:
 - (i) **Klinefelter's syndrome:** In this, the chromosomal pattern is XXY (47 chromosomes). The anatomical structure is of male but nuclear sex is that of a female. There is delay in puberty, behavioural disorders and mental retardation. Axillary and pubic hair are absent and hair on chest and chin are reduced. Gynaecomastia, azoospermia, low level of testosterone, sterility, increased urinary gonadotrophins, signs of eunuchoidism and increased height are usual characteristics. Testicular

dysgenesis and hyalinisation of seminiferous tubules is reported. Incidence is 1:500 and increases with advanced maternal age.

- (ii) **Turner's syndrome:** The chromosomal pattern is XO (45 chromosomes). It can be recognised at birth by oedema of dorsum of hands and feet, loose skin-folds in the nape of neck, low birth weight, and short stature. In adults, primary amenorrhoea, sterility, lack of primary and secondary sexual characteristics, increased gonadotrophins excretion, short stature, pigmented navel, a short fourth metatarsal, webbed neck, shield chest, midset Mongols nipples, high arched palate, low set ears, slow growth, spina bifida, coarctation of aorta, septal defects, renal defects, Cushing's syndrome and high incidence of diabetes mellitus are usual features. The gonads do not show primordial follicles.
- (iii) **True hermaphroditism:** It is a very rare condition, where testes or ovaries co-exist in the body, with external genitalia of both sexes. The gonads may be present in abdomen, inguinal canal or labio-scrotal position. There may be uterus or phallus may be penile or clitoral. The labia may be bifid as in the females or fused resembling scrotum of the male. They are usually sterile.
- (iv) **Pseudohermaphroditism:** In this, external characteristics of one sex may be there with gonads of the opposite sex.
 - A. **Male pseudohermaphroditism:**
Nuclear sex is XY but sex organs and sexual characteristics are of female form. There is testicular feminisation.
 - B. **Female pseudohermaphroditism:**
Nuclear sex is XX but deviation of sex organs and sexual characters towards male are seen because of adrenal hyperplasia.

2. **Concealed Sex:** Criminals may try to conceal their sex by dress, or by some other methods to avoid getting caught. It can be detected easily by clinical, histological, chromosomal or hormonal studies. In advanced stage of putrefaction, sex of the dead bodies can be detected by the presence of uterus or prostate, which resist putrefaction.

3. **Skeleton:** If skeleton is available, it is quite useful in the determination of the sex. The bones of adult females are usually smaller and lighter than that of adult male, and have less marked ridges and processes for muscular attachments. The frontonasal junction is not prominent. The orbits have sharp margins and are rounded. The adult female skull is lighter and smaller. Its cranial capacity being 10 per cent that of adult male. The protuberances are less prominent. The female thorax is shorter and wider than that of the male. The sternum of females are shorter and its upper margin is at the level of the lower part of the body of the third thoracic (dorsal) vertebra while in males, it is at the level of lower part of the body of the second. The sternal body is less than twice the length of manubrium in females while it is more than twice its length in the male. It is due to the fact that manubrium in the male is somewhat smaller than that in the female. The ribs are thinner and have greater curvature and the costal arches are larger in females.

The pelvis provides most reliable characteristics for distinguishing sex in over 90 per cent of individuals. The female pelvis is shallower, wider, smoother and less massive than the male pelvis. The ilium in females are less sloped, their posterior borders are more rounded and the anterior iliac spines are more widely separated and the great sciatic notches are much wider, forming almost a right angle, than in the male. A female sacrum is short and wide,

and is sharply curved forward in its lower half. A male sacrum is long and narrow, has a uniform curvature using its whole length and may have more than five segments. The obturator foramina are triangular in females and ovoid in the males. The ischial tuberosities are everted in males. The acetabula are narrow in the females and wide in the males. The pubic arch is wider in females, is more rounded, and forms an angle rather than an arch. The neck of the femur forms almost a right angle with its shaft in female, and an obtuse angle in the male.

Age

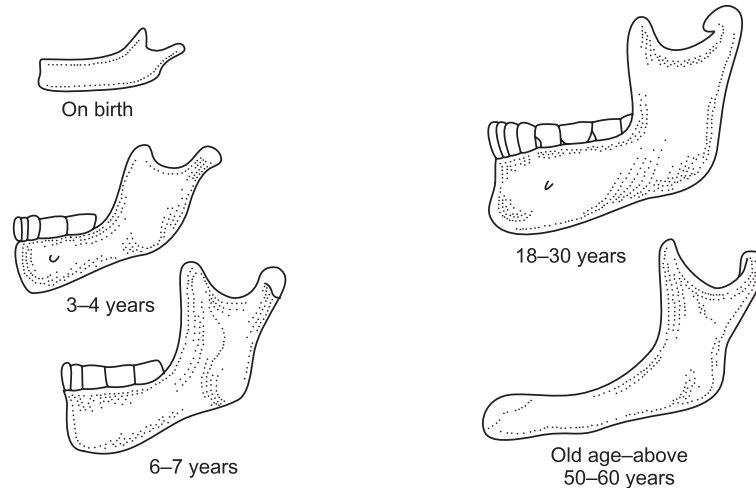
The principal methods by which age of a person can be determined especially in earlier years are teeth (Table 3.2), height and weight, ossification of bones (Table 3.1) and secondary sexual characters.

Teeth

By examining the teeth, the age of an individual can be ascertained up to 17–20 years of age. Beyond that it is merely a guess work. There are two types of teeth—temporary and permanent.

Table 3.2 Eruption of temporary and permanent teeth

Teeth	Temporary	Permanent
1. Central incisors		
(a) Lower	6th to 8th month	6th to 8th year
(b) Upper	7th to 9th month	
2. Lateral incisors		
(a) Lower	10th to 12th month	7th to 9th year
(b) Upper	7th to 9th month	
3. Canine	17th to 18th month	11th to 12th year
4. First premolar	Absent	9th to 11th year
5. Second premolar	Absent	
6. First molar	12th to 14th month	5th to 6th year
7. Second molar	20th to 30th month	12th to 14th year
8. Third molar	Absent	17th to 25th year



Temporary teeth: They are also known as milk teeth or deciduous teeth. They are 20 in number—4 incisors, 2 canines and 4 molars in each jaw.

Permanent teeth: They are 32 in number—4 incisors, 2 canines, 4 premolars and 6 molars in each jaw. The permanent teeth erupted in place of temporary teeth which start shedding from about sixth or seventh year (Table 3.3).

Each tooth has a crown, a neck and a root embedded in the jaw bone. It is composed of dentin, the crown is covered by enamel and the root by cementum which is attached to the alveolar bone by periodontal membrane. It is observed that dental and skeletal ages correspond in males, but in females the skeletal age is generally one year more than the dental age (Fig. 3.1).

Table 3.3 Differences between temporary and permanent teeth

Features	Temporary teeth	Permanent teeth
1. Size	Small	Large
2. Colour	Porcelain white	Ivory white
3. Constriction at crown-root junction	Present	Absent
4. Edges	Sharp	Serrated
5. Cusps	Few and small	More in numbers and highly developed
6. Number (Maximum)	20	32

Table 3.4 Sequence of appearance of centres of ossification and union of bones and epiphysis

Age	Appearance of centre of ossification	Union of bones and epiphysis
5th year	Head of radius, trapezium, scaphoid	Greater tubercle of humerus fuses with head
6th year	Lower end of ulna	Rami of pubis and ischium unite
6th to 7th year	Medical epicondyle of humerus	—
9th year	Olecranon	—
9th to 11th year	Trochlea of humerus	—
10th to 11th year	Pisiform	—
13th year	Separate centres in triradiate cartilage of acetabulum	—
12th to 14th year	Lesser trochanter of femur	—
14th year	Crest of ilium, head and tubercles of ribs	Medial epicondyle of humerus, patella complete
15th year	Acromion	Coracoid with scapula
16th year	Ischial tuberosity	Lower end of humerus, olecranon to ulna, upper end of radius, metacarpals, head of femur, lesser and greater trochanter of femur, acromion, lower end of ulna
17th to 18th year		
18th to 19th year	Inner end of clavicle	Lower end of femur, upper end of tibia and fibula, head of humerus, lower end of humerus
18th to 20th year		Iliac crest
21st year		Inner end of clavicle, ischial tuberosity

Gustafson's Method: It is used for age estimation in adults above 21 years of age. It depicts the physiological changes in each teeth with progression in the age. The important changes are periodontosis, attrition, secondary dentin, cementum apposition, root resorption and transparency of the root. Of all these, transparency of root is most reliable.

The four pieces of the body of sternum fuse with each other from below upwards between the age group 14 and 25 years. The xiphoid fuses with the body of sternum at about 40 years. The manubrium fuses with the body in very old age or sometimes does not fuse. The greater cornua of the hyoid bone fuses with body in 40–60 years of age. In skull, the anterior fontanelle closes and two halves of the mandible unite during the second year (Table 3.4 and Fig. 3.2).

Secondary Sexual Characters: The sequence of appearance of secondary sexual characters in males and females are as follows:

Males: At 14 years, fine hair begin to appear on pubis, the testes become large in size and penis begins to grow. At 15 years, hair growth on pubis is moderate and also starts in axilla. At 16 years, hair on pubis is fully grown and genitals acquire an adult appearance. Between 16 and 18 years, hair begin to grow on the face and voice becomes hoarse.

Females: At 13 years, breasts begin to develop and fine, pale, downy hair appear on mons pubis. The labia develops and menstruation starts. At 14–15 years, growth of pubic hair is good and starts in axilla too.

Medico-legal Importance of Age (Table 3.5)

The following is the medico-legal importance of age:

1. **Criminal Responsibility:** Under Section 82 of the I.P.C., any act done by a child under 7 years of age, is not an offense.

Under Section 83 of the I.P.C. a child between the age of 7 and 12 years is

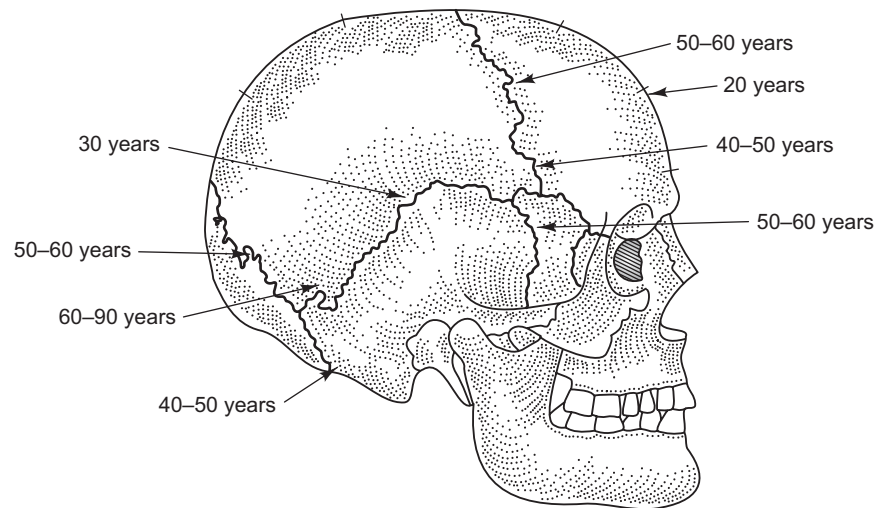


Fig. 3.2 Closure of cranial vault in years.

- presumed to be capable of committing an offense if he has attained sufficient maturity of understanding to judge the nature and consequences of his conduct on that occasion. This maturity is presumed in a child unless proved otherwise.
2. **Consent:** Section 89 of the I.P.C. states that a child under 12 years cannot give a valid consent to suffer any harm which may occur from an act done in good faith and for his benefit. Section 87 of the I.P.C. states that a person above 18 years of age can give valid consent to suffer any harm which may result from an act not intended or not known to cause death or grievous hurt. The child below 12 years cannot give valid consent for medical examination.
 3. **Juvenile Punishment:** According to the Juvenile Justice Act 1986, Juvenile means a boy who has not attained the age of 18 years or a girl who is below 18 years. The law has established separate courts for the juvenile and, instead of jail they are sent to juvenile home or Borstal school where there are facilities for education, vocational training and rehabilitation.
 4. **Rape:** According to Section 375 of the I.P.C., sexual intercourse by a man with a girl under 15 years, even if she is his wife or with any other girl under 16 years even with her consent, is an offense.
 5. **Kidnapping:** Kidnapping means taking away a person illegally from a lawful custody. It is an offense to (a) kidnap a child with the intention of taking any moveable property dishonestly, if the age of the child is under 10 years (Section 369 of the I.P.C.), (b) kidnap a minor from lawful guardianship if the age of the boy is under 16, and that of a girl is under 18 years (Section 361 of the I.P.C.), (c) push a girl for prostitution, if her age is under 18 years (Section 366A of the I.P.C.), and (d) import into India from a foreign country, a girl for purposes of illicit intercourse, if her age is below 21 years (Section 366B of the I.P.C.).
 6. **Employment:** A child below 14 years of age is not allowed to work in any factory or mine or any other hazardous work. However, a person completing 15 years is allowed to work in a factory as an adult if a fitness certificate is granted by a doctor.

Table 3.5 Medico-legal importance of age

<i>Age in years</i>	<i>Medico-legal relevance</i>
0–1 year	Infanticide
Less than 7 years	Criminal immunity
7 years	Criminal responsibility
10 years	Kidnapping for valuables
7–12 years	Guilty of offence if maturity present
12 years	Can give consent for medical examination except for procedures
14 years	Factory employment
15 years	Wife can give consent for sexual intercourse
16 years	Girl can give consent for sexual intercourse
16 years but less than 18 years	All offences to be tried under Juvenile Act
18 years	Attain majority. Right to vote. Consent for any surgery, marriage age for girls, kidnapping charges for girls
21 years	Attain majority when under guardianship of court Marriage age for boys
25–35 years	Age for entering government service
60–65 years	Age for retirement from government job

Under the Factories Act, 1948 an adult is defined as a person who has completed his 18th year. An adolescent is defined as a person who has completed his 15th year, but has not completed his 18th year; and a child is defined as a person who has not completed his 15 years.

7. **Attainment of Maturity:** A person attains maturity on completion of 18 years. However, if a person is under the guardianship of the court of law or is under guardian appointed by the court, he attains maturity on the completion of 21 years.
8. **Evidence:** The competence to depose does not depend on age but on understanding. If the court is satisfied that the child is truthful, any child of any age can give evidence in the court (Section 118, Indian Evidence Act).
9. **Marriage Contract:** A girl under 18 years and a boy under 21 years cannot contract marriage (Child Marriage Restraint Act, 1987).
10. **Infanticide:** In a court of law the charge of infanticide cannot be sustained if it is proved that infant was under the age of 6 months intrauterine life.
11. **Criminal Abortion:** A woman who has already passed the age of child bearing, cannot be charged of having criminal abortion.
12. **Impotence and Sterility:** A woman becomes sterile after attaining menopause. However, a boy can be sterile although not impotent before puberty.

Complexion and Features

The complexion may be fair, wheat coloured, dark, brown or shallow. The colour of an individual ranges from one area to another and depends upon race, patterns and weather conditions. The details

of the features regarding the eyes, nose, ears, lips, chin and teeth should always be carefully noted. The colour of irises, size of ear lobule should be noted. In certain individuals, lips may be thin or thick. The chin may be round, square, protruding or double (due to excessive fat). Expression of an individual changes after death.

Hair

Hair plays an important role in establishing identity as it resists putrefaction for a longer time. The hair of Indians is generally dark and fine, that of Chinese and Japanese is dark and coarse, while that of Negroes is curly and wooly. Some people in order to disguise their identity, might colour hair with henna, dyes or cosmetics. The hair may change colour in individuals working in certain trades like copper melters and indigo workers. To find out the chemical use of dyeing, a few strands of hair should be removed and they should be diluted in hydrochloric or nitric acid to dissolve the matter and then appropriate test should be done.

Medico-legal Importance of Hair

Hair is important in a crime investigation, as it sometimes remains on the body of the victim or on the alleged weapon. In rape and sodomy, pubic hair of the accused may be found on the victim or vice versa. Stains on the hair may sometimes indicate the nature of assault, for example, seminal stains in sexual offenses and salivary stains in asphyxial deaths. In chronic poisoning of heavy metals, the metal can be detected in the hair even after a long time. Singeing of the hair indicates burning.

Anthropometry

This system is used primarily for the identification of veteran criminals. It is also called Bertillon

system. It is applicable only to adults, as it is based on the principle that after 21 years of age no change occurs in the dimensions of the skeleton and ratio of the size of different parts to one another remains constant. Usual parameters which are taken are height of the person while standing, length of the head, width of the head, length of the right ear, width of the right ear, length of out-stretched arms, height of the trunk while sitting, length of the left foot, length of the left middle finger, length of the left little finger and length of the left forearm and hand. These measurements are recorded and kept. Certain peculiarities like the colour of irises or scars are also mentioned in the record. This system requires the employment of special instruments and large number of staff. This system has now been replaced by a better system called dactylography.

Dactylography

This is also known as the fingerprint system and consists of taking the impression of the pulp of the fingers and thumbs with printer's ink on an unglazed white paper. It is seen that individual peculiarities of the pattern formed by the arrangement and distribution of the papillary or epidermal ridges on the finger tips are absolutely constant and persist throughout life (from infancy to old age) and, that patterns of no two hands resemble each other. The fingerprints of even identical twins are different. The chances of two persons having identical fingerprints is about one in thirty times the population of the world.

This system was first used in India in 1858 by Sir William Herschel but it was Sir Francis Galton who established it. Fingerprints are classified in four groups, namely, loops (about 67 per cent), whorls (about 25 per cent), arches (about 6–7 per cent) and composite form (about 1–2 per cent). They are further classified into subgroups since arches can be plain or tented; loops can be radical or ulnar; and composite can be central pocket loops, twinned loops, later pocket loops and accidental (Fig. 3.3).

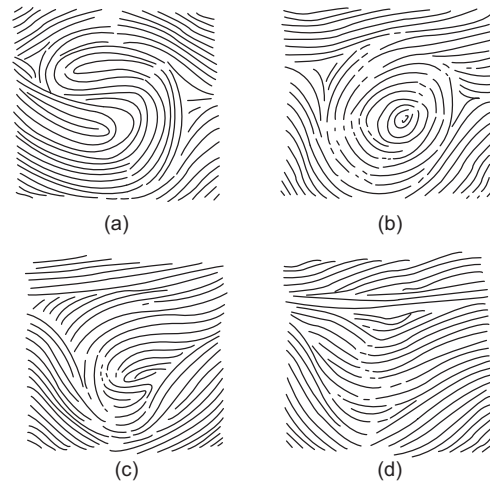


Fig. 3.3 Various types of fingerprints: (a) arch, (b) loop, (c) whorl, and (d) composite.

Poroscopy

It is a further modification of fingerprints, made by Locard. The ridges on fingers and hands are constituted of microscopic pores formed by openings of ducts of sweat glands. Each millimetre of a ridge contains 9–18 pores. These pores are permanent, and do not change throughout life. This method of examination is useful when only fragments of fingerprints are available.

Technique of Investigating Fingerprints

The hands are first washed, cleaned and dried. The fingerprints are recorded on an unglazed white paper using printer's ink. There are two types of prints which are taken: (a) **plain fingerprint**—is taken by applying ink to the tips of the fingers and placing the fingers directly on paper. In this, the whole contour of the pattern does not appear; (b) **rolled fingerprint**—is taken by rolling the fingers on papers so as to obtain impression of the whole tip.

Fingerprints on paper, wood and fabric can be developed by treating them with sulphur nitrate solution, and then fixing them with sodium thiosulphate. Fingerprints can also be developed exposing it to the vapours of iodine.

Criminals sometimes attempt to mutilate the patterns of fingerprints by inflicting wounds or burns, application of corrosives but they are not obliterated unless true skin is completely destroyed. Certain diseases like leprosy may modify the fingerprints. Electrical injury and radiation may also cause impairment. In criminal cases, impression of all the 10 fingers are taken, but for civil purposes the left thumb impression is taken in case of males and right thumb impression in case of females.

Footprints: The skin pattern of toes and heels are as distinct and permanent as those of fingers. In case of maternity hospitals, footprints of newborn infants are taken to prevent exchange. Some individuals have also advocated the use of palate-prints and lip-prints in the identification of individuals.

Deformities

They may be congenital or acquired, and are quite useful in the identification of individuals. Deformities like cleft palate, hare-lip, supernumerary fingers of toes, supplementary mammae, web fingers or toes and muscles are congenital. Clear or acquired deformities, such as ununited or malunited fractures are quite useful in the identification of the individual.

Scars

A scar is a fibrous tissue covered by epithelium formed as a result of the healing process of a wound or injury in which there has been a breach of continuity. It does not contain hair follicles, pigment or sweat glands. Generally, a scar assumes the shape of the wound causing it. A scar resulting from an incised wound is usually straight. Broad and irregular scars are caused by lacerated wound. A scar appears in 4 or 5 days after healing under a scab. It is difficult to tell the exact age of a scar. When first formed, a scar is light, tender and covered by a scab. Subsequently, it turns brown and finally white. These changes are generally seen

in 3–4 months. Some scars located in the chest and limbs grow in size with the natural development of the individual, if the injury has been inflicted in childhood.

Tattoo Marks

Tattooing is prevalent all over the world and is more common among persons of low socioeconomic status, persons involved in crime, prostitutes, religious fanatics and punks. Tattooing is done mostly by puncture in which tattoo particles of insoluble pigments are introduced into the dermis (such as vermilion, cinnabar and ultramarine). Designs of various kinds from initials to Gods of worship, and sometimes tattoo posture of sexual activity are seen. It has been observed that tattoo marks may disappear during life without leaving any trace on the body after a considerable time, namely, in years. It is mostly seen in cases where the pigment used is vermilion or ultramarine and if it is perforated deep into the skin. Tattoo marks may be removed artificially by (a) surgical methods, (b) electrolysis, and (c) application of corrosives. Small pox and chronic eczema have been shown to cause obliteration of tattoo marks (Fig. 3.4).



Fig. 3.4 Tattoo mark.

Occupational Marks

They are quite useful in identification of unknown dead bodies as certain trade practices leave marks. For example, horny and rough hands are observed in individuals doing hard manual labour. *Kahars* and *dooly* bearers usually have a hardened callous on their shoulders. Callosity on the hypothenar eminence and right palm is seen in persons involved in weighing goods.

Callosity on the right middle finger distal interphalangeal joint, where the pen usually rests, is seen in clerks, and depression in the lower part of the sternum is found among shoe-makers. Tailors have marks of needle punctures on their left index finger. Engineers, dyers, chemists and photographers generally have their fingers stained with dyes or chemicals. These occupational marks are quite useful in the identification of an individual.

Handwriting

A person may be identified by his handwriting. But to identify a person from handwriting requires highly skilled experience. However, handwriting experts are not at all infallible and their evidence may be conflicting. It is observed that mental and nervous diseases, especially those causing tremors, may alter the character of writing by producing more or less irregularities in the formation of letters.

Miscellaneous Methods of Identification

The following are the miscellaneous methods of identification of an individual:

1. **Clothes and Personal Articles:** They do not form any special basis for evidence in identification of living persons, as the individual may change them at will. But they are very useful in establishing the identity of a dead body, particularly in a mass disaster. The clothes can be identified by the presence of marks of a *dhobi* (washerman) or that of a tailor.
2. **Speech and Voice:** Certain peculiarities of speech like stammering, stuttering, hissing and nasal twang are characteristics of certain individuals. However, speech can be affected in many nervous diseases and trauma. Also, many cases have been reported in which the impersonator has been successful in keeping the exact patterns of speech.
3. **Gait:** Individuals can be recognised from a distance by watching their gait but this evidence is far from conclusive as the gait may be altered by an accident or disaster.
4. **Ticks, Manners and Habit:** These are usually hereditary, e.g. left-handness. However, repetitive jerky movements of shoulders or the muscles of face may be an individual characteristic.
5. **Mental Power, Memory and Education:** Certain individuals have described various methods of identification based on the fact that no two electrocardiograms (ECG) are the same. Some have used lip-prints for identification. Some have compared X-rays of frontal sinuses after the age of 15. Some individuals have advocated the use of footprints and palatoprints for identification. But all these methods are not standardised, so cannot be relied upon.

Post-mortem Examination

The post-mortem examination is a legal requirement when the cause of death is not known. The objectives of a post-mortem examination are:

1. To establish the identity of an individual
2. To know the cause of death
3. In case of a newborn whether the foetus was viable or not.

The cause of death is defined as disease or injury which results in death. The manner of death explains how the cause of death came into being. The manner of death may be natural or unnatural. When a person dies because of some disease, the manner of death is natural. If he dies because of some injury, the manner of death is unnatural, which may be homicidal, suicidal, or accidental. The mode of death is the physiological process which causes death like asphyxia, coma, and syncope.

CONDUCTING A POST-MORTEM EXAMINATION

The post-mortem examination is conducted only on the written request of the police or magistrate. In normal circumstances, a police officer or a magistrate brings the dead body, along with the inquest paper, to a mortuary for post-mortem examination. But sometimes, if it is not possible to bring the dead body to the mortuary, the doctor may be asked to go to the scene of the crime and conduct post-mortem examination. This is sometimes seen in hills where a vehicle may fall into a deep trench resulting in death, and it may

not be possible to bring the bodies to the mortuary; in such cases the doctor conducts the post-mortem on the spot. Also, in cases that require exhumation, the post-mortem is conducted on the spot.

Before a post-mortem examination, the doctor should read all the inquest papers. The inquest papers contain brief facts of the case, statements of witnesses, a map of scene of crime, medico-legal report, death report, etc. He should also go through the enquiries made by the investigating officer. The post-mortem should preferably be conducted in daylight. Although there is no bar to conduct a post-mortem examination at night, there should be adequate light if post-mortem is conducted after sunset. It is advised that if a post-mortem examination is carried out after sunset, necessary permission from appropriate authorities may be sought. The post-mortem examination should be complete and thorough. All the great cavities and organs should be examined thoroughly. A partial post-mortem is not allowed.

The post-mortem report consists of following components:

1. **Preamble:** The name of the deceased, the gender, address, time of arrival of the body, date and place of examination, name of the police officer who brought the body and name of the relative who identifies the body, should be noted.
2. **The Body of the Report:** It consists of complete account of external and internal examination. All the injuries on the body are described. Marks of identification should be recorded.

3. **Opinion:** This is the most important aspect of the report. An opinion regarding the cause of death is provided after careful consideration of all the findings. The opinion should be brief, clear and honest. It should be based on scientific facts and terms like probably, nearly, etc., should be avoided while expressing opinion regarding the cause of death.

After expressing his opinion the doctor should put his signature, complete name, designation and address below the signature. It is better to put the official seal. No unauthorised person should witness a post-mortem examination. The doctor should preferably write the report immediately after the post-mortem examination and hand it over to the police official or the magistrate. The copy of the report should not be given to any unauthorised person.

External Examination

Before starting external examination, height and weight of the body should be taken. Observation regarding nutrition, physique should be made. In case of unknown bodies, fingerprints along with photographs should be taken. Marks of identification like moles, scars, tattoos, deformity, etc. should be noted.

The following procedure should be followed for external examination:

1. The body must be identified by police constables who brought the body and it should be cross-checked with relatives of the deceased. This is necessary especially in burn cases and when the body is highly decomposed, since facial features of the person may have been obliterated due to burns or decomposition.
2. The clothes on the body should be examined carefully for stains and tears as these may indicate struggle before death. The pockets of the clothes should be checked and any item found should be noted in the post-mortem report.
3. If ligature material is seen around the neck, its position, manner and application of the knot should be recorded accurately.
4. A rough estimate of age should be made from general body, teeth examination or other physical appearances.
5. All the natural orifices like mouth, nose, ears, anus, urethra and vagina should be inspected for injuries, discharges, or foreign bodies. Swabs should be taken in suspected cases of sexual assaults.
6. The signs of decomposition and post-mortem changes should be carefully noted.

Extent of rigor mortis, post-mortem staining, changes in cornea, and dripping of saliva should be noted.

After cleaning the body, all the injuries present on the body should be noted. All the injuries should be described in detail. The length, breadth and depth should be exactly noted. If the injuries are deep, the distance of each injury from two fixed points on the body should be noted. Fixed points of the body include bony prominence, median plane, etc. The description of the injury should be made in such a manner that the doctor is able to reconstruct the same in a court of law, if requested. Injection marks present on the body should be carefully noted. If required for testing purposes, a portion of skin (2.5 cm × 2.0 cm) containing injection mark with subcutaneous tissue and muscles should be preserved. A similar piece from the opposite side should also be taken as control specimen. The length, breadth, direction and colour of bruises and abrasions should be noted. All bruises should be incised to confirm infiltration of blood beneath the skin so as to confirm their status as ante-mortem or not. No probe should be introduced in deep or penetrating wound till the body is opened up. In case of fire-arm injuries, blackening around the entire wound should be carefully noted. In case of burns, exact size, portion and extent should be noted. In case of an infant, the condition of the umbilical cord should be inspected—whether it is tied, torn or cut.

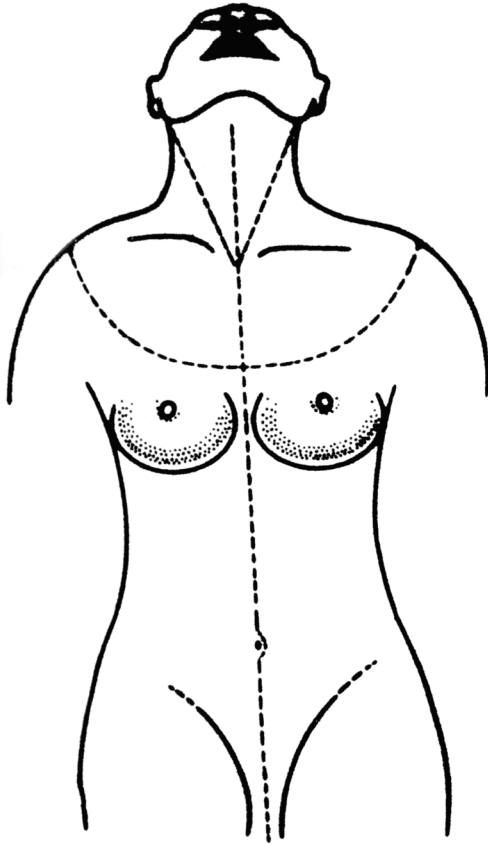


Fig. 4.1 Types of incisions for opening the body.

Internal Examination

All the three cavities, head, thorax and abdomen should always be opened. There is no fixed sequence of opening these cavities, but in case of alleged infanticide, the head should be opened first so that the contents of the skull can be examined before blood is drained out by opening other cavities. In normal cases, thorax and abdomen are opened first and head later on. The spinal cord is normally not opened up. Only in cases of suspected spinal injury or poison it is opened up. In all other cases it is opened last (Fig. 4.1).

Examination of Head

The head is opened by giving first a transverse incision across the vertex from ear to ear and flaps are reflected anteriorly up to orbits and posteriorly below the occipital protuberance. The inner surface of the scalp should be examined for extravasation of blood, petechial haemorrhages or injuries. The skull bones should be examined for any fracture or separation of sutures, after the periosteum is denuded and temporal muscles cut. The skull cap is removed by making a circular cut by a saw around the cranium just above eye bridges keeping within reflected caps. The inner surface of the cap should be inspected for fracture of inner plate and any haematoma present. Any extra-dural haematoma may be noted once the skull cap is removed and condition of the dura should be noted. The dura is removed by cutting longitudinally along both the sides of the midline, and any subdural and sub-arachnoid haemorrhage should be noted. The brain is removed by raising the anterior lobes with fingers of left hand and cutting the nerves at its base and the medulla as low as possible. The brain should be examined for any injuries, embolism, or petechial haemorrhages. Different sections of the brain should be cut to inspect carefully. The dura mater should be removed from the base of the skull at last, and fractures should be examined if present on the base of the skull or around.

Examination of Thorax and Abdomen

The thorax is opened by giving longitudinal incision from above the middle of the sternum to the pubic bone, avoiding any wounds present in the line. The skin and muscles are reflected. The abdominal cavity should be examined first, before the thorax is opened. The position of the diaphragm, any presence of blood, pus, or foreign body in the abdomen should be noted. The thorax is opened by dividing the ribs at their cartilages and the sternum at the sternoclavicular junction with a cutter and lifting up the sternum in such a way that

it does not injure the underlying parts. The pleural cavities should be examined for the presence of any blood, pus, or injury.

The heart is examined by opening the pericardium. The lungs and heart should be removed and examined. The condition of the heart should be seen for enlargement or any injury present. All the chambers of the heart should be examined for any thrombus, embolus, etc. All coronary arteries should be examined by giving a small incision for any blockage or atherosclerosis. The dissection of the heart is done in the direction of flow of blood for better appreciation. The lungs should be examined for injury, collapse, diseases, etc. To examine bronchioles and air passages, dissection of lungs should be done through hilum. All the bronchioles can be opened by following their directions as they go inside the lung. The trachea and bronchioles should be examined for the presence of water, blood, foreign body, pus, etc. The aorta and rib cage should be inspected for any injury or disease. An incision is made from the chin to the upper part of the sternum after the head is placed backward, and a piece of block is kept below the neck. The skin is reflected and the neck is examined layer by layer by cutting the muscles. Any extravasation of blood or injury to blood vessels, muscles, thyroid, cricoid cartilage, hyoid bone should be noted.

The trachea and oesophagus should also be inspected. The peritoneal cavity should be examined for adhesion or injury. The abdominal organs should be removed and inspected:

1. **Stomach:** The stomach should be removed by tying a ligature 3–5 cm above the cardiac end and another at the pyloric end. It is opened along the greater curvature and its contents examined. The mucosal surface of the stomach should be carefully inspected for congestion. The contents of the stomach should be weighed and their degree of digestibility should be noted. Any particular smell of contents should always be noted.

In case of suspected poisoning, the entire stomach along with its contents is preserved.

2. **Intestines:** Both small and large intestines should be inspected by cutting the mesentery and examined for congestion, ulcer & perforation. In cases of suspected poisoning a small part of the upper intestine is preserved.
3. **Liver:** The liver should be examined for any injury, disease, etc. The surface of the liver should be inspected. The gall bladder, pancreas and spleen should also be inspected for any disease or injury.
4. **Kidney:** The kidneys should be inspected by cutting open and examined for any injury or diseases (Table 4.1).
5. **Urinary bladder:** It should be examined for its contents and surface. In case of suspected poisoning, urine can be collected by a catheter before opening the bladder. The prostate and testes should be examined by cutting section.
6. **Uterus:** In a female body the examination of uterus is very essential. In nulliparous women, it is of very small size, around 7.5 cm × 5 cm × 2.5 cm. Its weight depends on whether the woman is pregnant or not. Uterus should be cut longitudinally and its inner surface should be examined for any changes. The ovaries and fallopian tubes should also be examined.
7. **Spine and Spinal Cord:** In normal circumstances, it is not opened up. But if some injury or disease is suspected, it is opened up. The body is turned over on the face and a block is kept below the thorax; and an incision is made along the entire length of the vertebral column from the occiput to the lower end of the sacrum. After reflecting muscles and skin, the lamina are cut by a saw and the spinal cord is inspected. The vertebral column should be inspected for any fracture, disease, etc. After the post-mortem examination is over, all

Table 4.1 Weight capacity of common organs/structures

<i>Organs/Structures</i>	<i>Male</i>	<i>Female</i>
1. Brain	1400–1450 gm	1275–1300 gm
2. Spinal cord	30–45 gm	30–45 gm
3. Heart	300–350 gm	250–300 gm
4. Thyroid gland	20–40 gm	20–40 gm
5. Lungs		
Right Lung	360–570 gm	360–570 gm
Left Lung	325–480 gm	325–480 gm
6. Liver	1400–1500 gm	1400–1500 gm
7. Spleen	150–200 gm	150–200 gm
8. Kidney	130–160 gm	120–150 gm
9. Testis	20–25 gm	Not Applicable
10. Ovary	Not Applicable	5–7 gm
11. Uterus		
Nulliparous	Not Applicable	30–40 gm
Multiparous	Not Applicable	100–120 gm
12. Stomach		
Length	25–30 gm	25–30 gm
Capacity	1100–1200 ml	1100–1200 ml
13. Small intestine	550–650 cm	550–650 cm
14. Large intestine	150–170 cm	150–170 cm
15. Vagina		
Anterior wall	Not Applicable	7.5 cm
Posterior wall	Not Applicable	10 cm

the organs are replaced in the body, and the body is stitched up and covered with cloth; and then handed over to police who then forwards it to relatives for disposal.

Preservation of Viscera and Other Articles

In suspected cases of poisoning, the viscera is preserved to rule out common poisoning. The viscera should be preserved in clean, wide-mouthed glass bottles fitted with glass stoppers. The following viscera are preserved commonly:

1. Stomach with all its contents.
2. Small intestine along with contents. About 1.0 m in adult, 1.5 m in children and whole in infants.
3. *Liver*: About 400–500 gm; whole in infants.
4. *Spleen*: Half in adults and whole in infants and children.

5. *Kidney*: Half each of both kidneys in adults, but both in children and infants.

6. *Sample of blood*: A gauze piece is soaked in blood, and then dried before handing over.

7. *Sample of preservative*: Commonly, the above viscera are preserved in a saturated solution of common salt. A sample of preservative is also given along with viscera as a control.

The stomach and small intestine along with their respective contents are preserved in one bottle while liver, spleen, and kidneys are preserved in another bottle. The blood sample should be preserved separately. If alcohol is suspected, sodium fluoride should be used as the preservative. In all acid poisoning except carbolic acid, rectified spirit should be used as a preservative. Sufficient quantity

of preservative should be used as to occupy about three fourth of the bottle. If some volatile substance is suspected, e.g. a poison, paraffin oil should be put above the layer of the preservative so that volatile substance is not evaporated. Vomitus present should be preserved (at least 300 ml, or the entire quantity if less).

After all the viscera bottles are sealed, they should be put in a box and sealed. It should be handed over to police for onward transmission to the Forensic Science Laboratory. Nowadays, due to modern techniques, less quantity of viscera is required for extraction of poison. Formalin should never be used as a preservative. A sample of the seal should always be given along with box to the police.

Following items are also preserved in special situations:

1. Portion of the brain and the heart in rectified spirit in cases of poisoning, where nux vomica or strychnine is suspected.
2. Lungs and blood from the cavity of the heart are preserved in cases of suspected poisoning by carbon monoxide, alcohol, chloroform, or hydrocyanic acid.
3. The cerebrospinal fluid is preserved in suspected alcohol poisoning.
4. A portion of the skin, subcutaneous and muscle tissue in cases of poisoning by injection.
5. A few pieces of long bones about 15 cm long in suspected poisoning by arsenic or antimony. In such cases the finger nails and hair should also be sent with skin samples.
6. The uterus along with its contents should be preserved in criminal abortion.

Cause of Death

After completing the post-mortem examination, it is the duty of the doctor to give the cause of death after careful consideration of all the findings observed in the post-mortem examination. The doctor should write the post-mortem report immediately after the post-mortem examination is over and hand it over to the concerned police officer or magistrate. If it is not possible to write the report immediately, it should be completed as early as possible. If the doctor needs help he should not hesitate to seek it. The rough notes should be destroyed immediately after the report is written. The report should be detailed, concise and clear. Unnecessary use of phrases/words like 'most probable' or 'likely' should be avoided. If the doctor is not able to form an opinion immediately and needs report of the viscera, the cause of death should be kept pending and reasons should be written in the final report. A duplicate copy of the report should be kept for records.

Alternative Way of Post-mortem Examination

The following are the alternative ways to know the cause of death:

1. **Psychological Autopsy:** The term is sometimes used when perusal of medical and personal history is done along with circumstantial evidences like suicide note, scene of crime, etc. This is quite useful in cases of suspected suicide where mindset of the person who committed suicide is analysed. In reality, it is not an autopsy.
2. **Endoscopic Autopsy:** If for any reason, conventional autopsy is not possible, then a post-mortem endoscopic examination can be done in some cases through a telescope device attached to a video camera.

Examination of Decomposed and Mutilated Bodies, Skeletal Remains, and Exhumation

EXAMINATION OF DECOMPOSED BODIES

Sufficient care should be taken while examining decomposed bodies, as features may be altered and there may be difficulty in appreciating injuries. Due to an advanced stage of decomposition, the ligature mark on the neck may not be appreciated well as the skin may be peeled off. The shape of the injuries may be altered by maggots present on the body. Sometimes, the body may be in such an advanced form of decomposition that the cause of death may not be found. In all such cases, the viscera should be preserved. Facial features may be distorted due to decomposition and may pose problems in identification. In such cases, the body may be identified by other features like clothes, tattoo marks, fingerprints, etc. If no cause of death is finally possible, it may be mentioned in the post-mortem report that no cause of death could be found due to advanced stage of putrefaction.

EXAMINATION OF MUTILATED BODIES OR FRAGMENTS

The body may be found in a mutilated form not only as a result of a criminal act but also due to animal bites. Sometimes, it may happen that because of an accident or severe trauma or bomb blast, only parts of the body are found. In all such cases, the first effort to be made is to decide whether the

parts are of a human body or not. It can be done by close examination; by chemical test like precipitin test with anti-human sera or by anti-globulin inhibition test.

After it is determined that fragments belong to a human body, following points should be carefully noted:

1. All the body parts should be arranged in anatomical order to find out if they belong to more than one person or not.
2. The nature and character of parts should be observed as to how they are separated. It should be appreciated whether parts are cut or lacerated, or gnawed by animals.
3. The sex of the individual can be found out by facial features, body parts, shape of pelvis, external genitalia, bones, soft tissues like uterus or prostate and mammary glands.
4. The probable age can be found out from skull, teeth, colour of the hair, secondary sexual characteristics and ossification of bones.
5. Identification of the person may be made by facial features, tattoo marks, fingerprints, scars and deformities. Height can be calculated by measurement of bones.
6. Time since death should be calculated from the decomposition stage of various body parts.

7. The cause of death should be determined by the *presence of injuries on the body*.
8. Identity of an individual can be established by **Superimposition Technique**. In this, a life-size photograph of the person is superimposed on the skull of the person to look for similarities. For this, the skull should be cleaned properly with hydrogen peroxide solution. Although this technique has only corroborative value, it is useful in many cases.

EXAMINATION OF SKELETAL REMAINS

Sometimes an entire skeleton or, a bundle of bones is sent by the police and various questions are raised about whether they are of a human or not, what is their age, sex and cause of death, etc. The examination of bones should proceed in following manner:

1. To determine the bones, whether they are of a human being or not, one should have a knowledge of the human skeleton and its comparison with those of other animals. If in doubt, the precipitin test with anti-human sera can be done to determine whether bones are of a human being or not.
2. The sex of the skeleton can be determined on examination of bones (Table 5.1). If the entire skeleton is present, grade (percentage) of accuracy of sex determination is 100 per cent. If the skull and pelvis are there, it is 98 per cent. If pelvis and long bones are there it is still 98 per cent. But if pelvis alone is there it is 95 per cent. It decreases to 93 per cent if skull alone is present. In case of long bones it is 85 per cent. Sex determination of bones can also be calculated by noting down the length and breadth of various bones.
3. The height of the individual can be estimated by keeping the following facts in mind:
 - (a) If the complete skeleton is present add 2.5 cm for soft parts to entire length of the skeleton.
 - (b) As a general rule, the stature of a person is approximately equal to the length measured from the tip of the middle finger to the tip of the opposite middle finger with arms extended horizontally.
 - (c) If only one arm is there, height can be calculated by multiplying its length by two and adding 30 cm for clavicles, and 4 cm for width of sternum.
 - (d) The length of the forearm measured from the tip of the olecranon process to the tip of the middle finger, is also stated to be equal to five-nineteenth of the height.
 - (e) The length of head is one-eighth of the height of the body.
 - (f) Symphysis pubis forms the centre of the body from 20–25 years of age.
 - (g) Height can also be determined by using multiplication factors available to the length and breadth of various bones. The various formulas commonly used are Karl Pearson's, Krogman's and Trotter and Gleser's formulae. Greater accuracy of the height can be ascertained after taking sex of the individual, and regression formula into consideration.
4. The age of the individual is determined by the presence of teeth, their number, wear and tear, presence of centres of ossification and their fusion with shaft. The approximate age should be given after consideration of all these factors.
5. Sometimes, it is very difficult to determine the time since death but the following criteria can help:
 - (a) Look for fractures and stage of callus formation.
 - (b) Look for condition of soft parts. Their stage of decomposition may give an idea.
 - (c) Bones begin to decompose in three to four years.

Table 5.1 Sex difference in various bones of human skeleton

<i>Bones</i>	<i>Male</i>	<i>Female</i>
1. Total skeleton weight size	4.5 kg large	2.75 kg small
2. Skull		
Frontal surface	Irregular	Smooth
Orbit	Rectangular large	Round and small
Bony prominence	More prominent	Less prominent
Palate	U-shaped	Parabola
3. Mandible		
Size	Large	Small
Chin	U-shaped or square	V-shaped
Body-ramus angle	Less obtuse	More obtuse
Angle of mandible	Exerted	Not much exerted
Condyles	Large	Small
4. Pelvis		
Inlet	Heart shaped	Oval
Cavity	Conical and funnel-like	Broad and round
Subpubic angle	V-shaped	Wide and U-shaped
5. Hip bones		
Preauricular sulcus	Faint or absent	Well marked
Greater sciatic notch	Small, narrow and deep	Large, wide and shallow
Body of pubis	Triangular shape	Square shaped
Ischial tuberosity	Inverted	Everted
6. Sacrum		
Size	Large and narrow	Small and broad
Length	More	Less
Width	Less	More
Curvature	Uniform	Abrupt
Sacral promontory	Prominent	Less prominent
7. Femur		
Head	Large	Small
Neck-shaft angle	Wider	Narrow
Bicondylar width	More	Less
Bony prominence	Prominent	Less prominent

6. It is difficult to know the cause of death from bones unless there are evidences of injuries like fractures or cuts. The injuries produced by animals by cutting and gnawing should be differentiated from injuries produced by a sharp-edged weapon, otherwise a wrong opinion can be formed. Metallic poisons can be detected by chemical analysis of bone ash. Poisons that can be detected are arsenic, antimony, lead, or mercury.

7. *Examination of burnt bones:* Sometimes, burnt bones are forwarded by the police for examination. It should be remembered that in a household fire, the temperature usually does not go beyond 1200°C which renders all bones to ashes. It is only during cremation that the temperature goes around 1600°–1800°C for at least 90 minutes to reduce bones into ashes. Even then, some bones can be identified. While examining burnt bones, a distinction should be made

whether fractures are due to injuries or due to heat. When bones, especially long bones and skull are exposed to high heat, curved fractures may be seen. Even in burnt bones, arsenic can be detected on chemical examination.

EXHUMATION

Sometimes, it is necessary to exhume bodies from graves when there may be doubts regarding cause of death, some foul play like abortion, or disputed bodies. Even in cases of doubtful identification, malpractice or insurance claim, exhumation may be done.

Rules

The exhumation can be done only on the orders of the magistrate. Previously, coroners were also authorised by law to order exhumation, but since the abolition of the coroner system, an exhumation can be done only on the orders of the magistrate. It should always be done under natural sunlight and should not be conducted after sunset.

Procedure

For exhuming bodies following steps should be taken:

1. After receiving a written order from the magistrate, the doctor should proceed to the site immediately.
2. Before beginning to dig the grave, it should be identified by the undertaker or by the police.
3. The grave should now be dug. Condition of the coffin should be noted and preferably be identified by the person who has made it.
4. In cases of suspected poisoning, 500 gm of earth in actual contact with the body should be kept for chemical analysis as control sample.
5. The body should be taken out and post-mortem examination should begin there itself.
6. Photographs should be taken while all the examinations are going on.
7. The post-mortem should be done away from the eyes of people by covering and cordoning the area.
8. The complete post-mortem examination should be done to ascertain identification, age, time since death and cause of death.
9. Sample of viscera, hair, nails, etc., may be preserved for chemical analysis.
10. After post-mortem examination, the body may be re-kept in the grave for burial.
11. At no stage should disinfectants be used on the body.
12. The sample of earth taken as control near the body should also be forwarded for chemical analysis.
13. In India, there is no time limit prescribed for ordering exhumation. In France, it is 10 years and in Germany it is 30 years.

Examination of Biological Stains and Hair

MEDICO-LEGAL IMPORTANCE

Biological stains and hair carry great medico-legal importance. They are usually found at the scene of crime and sexual assault cases, and are required to be examined to establish identity of the person involved in the crime. Examination of biological fluids may be required in the following cases also:

1. Disputed paternity in cases of adultery and divorce.
2. Disputed maternity in cases of kidnappings, inheritance, etc.
3. Exchange of infants at hospitals.
4. Identification of individuals involved in disasters, accidents, etc.

METHOD

Examination of Blood

A fresh sample of blood is taken in cases of problems like disputed paternity. Let us first discuss various antigen systems by which blood is identified into groups:

1. **Red Cell Antigens:** There are various antigens on red blood cells by which group of blood can be identified, common being ABO, MNS, Rh system, etc.

- (a) **ABO group:** There are four basic blood groups: A, B, AB and O. There are three

allelic genes A, B, and O. Each child inherits one gene from one parent. The possible phenotype and genotype expression of the four blood groups are enumerated in Table 6.1.

Table 6.1 Expression of blood groups

Phenotype	Genotype	Antigen present	Antibodies in serum
1. A	AA AO	A	Anti-B
2. B	BB BO	B	Anti-A
3. AB	AB	A and B	None
4. O	OO	None	Anti-A and anti-B

Antigens of ABO system can be detected even in an unborn child. The antigen in ABO groups are detected by using anti-A, anti-B and anti-O sera. In India, B group is the most common. A person with AB group is a universal recipient while one with O group is a universal donor.

- (b) **MNS system:** It was discovered by Landsteiner and Levine. There are four red cell antigens namely, M, N, S and s. These antigens are inherited as dominant Mendelian factors. A child can inherit either M or N, and S or s from each parent. Various phenotypes and genotypes possible are listed in Table 6.2 and help in exclusion of paternity.

Table 6.2 MNS group

<i>Genotypes</i>	<i>Phenotypes</i>
1. MS/MS	MS
2. MS/Ms	MSs
3. Ms/Ms	Ms
4. MS/NS	MNS
5. Ms/NS	MNs
6. Ms/Ns	MNs
7. NS/NS	NS
8. Ns/NS	NSs
9. Ns/Ns	NS

(c) **The Rh system:** This system consists mainly of five antigens D, C, E, c and e. Since antibodies were obtained by depositing Rhesus monkey blood in rabbits and guinea pigs, it was called Rh system. In clinical practice, mainly D antigen is used for blood transfusion. Those who have D antigen are called Rh +ve while the rest are called Rh –ve. In India, 85 per cent of population is Rh +ve. Various phenotype and genotype combinations are possible with other antigens by which exclusion of paternity can be done.

(d) **Other system:** Besides ABO, MNs and Rh, there are other systems for examination also like Kell system, Duffy system, Kidd system, Lutheran system, P system, Xg system, Cotton and Yt system, which can also be used. But nowadays, they are rarely used in view of recent techniques.

2. White Cell Antigens: HLA system (human leucocyte antigen system) – These antigens are present on white blood cells and consist of 68 factors which are now classified into four loci, A, B, C and D. Individual alleles of each locus and its antigen were designated by numbers following the designation of the locus, like HLA–A10, HLA–B27. The genes of the system are inherited as codominant Mendelian characters. The child gets four genes each from each parent. Four genes inherited from one parent are called haplotype and one genotype contains two haplotypes. There are

more than 200 haplotypes or 60,000 genotypes recognisable even with the use of two loci. So, there is a wide range of differentiation for inclusion or exclusion in paternity cases. HLA system is very superior as compared to other systems, and up to 98 per cent exclusion can be possible with this system. HLA system is widely used in transplantation procedures to identify the correct and the most suitable donor.

3. Serum Allotypes: There are differences in serum proteins in humans. Various proteins give patterns which are called allotypes consisting of allomers (genetically controlled) and allomorphs (genetically not controlled). Based on these differences in serum proteins, various systems like Gm, Km, haptoglobin, Gc, Ag, Lp, Xm, albumins, and transferrins were found which can help in cases of disputed paternity.

4. Red Cell Enzymes: Erythrocyte acid phosphates (EAP) system, Adenylate kinase (AK) system, adenosine deaminase (ABA) system, phosphoglucomutase (PGM) system, 6-phosphogluconate dehydrogenase (6-PGD) system, esterase D (ESD) system, and glyoxalase (GLO) system are the few isoenzyme systems that have been developed for disputed paternity testing.

Examination of Blood Stains

Blood stains can be found on soil, clothes, body or any other place. It may be mixed with other body fluids. The blood stain has to be carefully lifted. Take a sample to laboratory, if possible. If it is not possible, sample may be lifted with a moist cotton and transferred to a slide. The first step in examination of a blood stain is to verify if it is a blood stain or not. Blood is identified by the presence of haemoglobin in red blood cell or serum proteins.

Tests for Identifying Blood

The tests of blood are as follows:

1. Screening Tests for Blood: These tests are based

on the presence of peroxidase enzyme activity of haemoglobin which releases nascent oxygen from hydrogen peroxide when added to it. This nascent oxygen changes colour of the reagent added.

Benzidine test: In this, benzidine solution is added along with hydrogen peroxide, an intense blue colour is seen if blood is present.

2. Kastle-Mayer test: In this, phenolphthalin is added instead of Benzidine, pink colour is seen if blood is present.

Benzidine test is very sensitive as it can detect blood in 1 in 1,000,000 dilutions. Phenolphthalin test is more specific, but less sensitive.

A negative test while screening may rule out the presence of blood but there may be a false positive test also. Some vegetable stains, salivary stain, rust or pus may give a positive test.

Confirmatory Tests for Blood

The following are the confirmatory tests for blood:

- 1. Microscopic Examination:** It is very good for fresh blood as it can identify the presence whether that of red blood cells or of white cells, under the microscope. In cases where only stain is present, a stain extract is made and then it is examined under microscope for blood cells. Staining of the stain extract with Leishman stain is useful as sex of the deceased can be found out by counting Davidson bodies in polymorph cells.
- 2. Crystal Test:** This test is based on the property of iron in the haemoglobin to form characteristic coloured crystals with certain reagents. These crystals can be easily seen under a microscope. In haemochromogen crystal test, pink feathery crystals can be seen. In haemin crystal test, dark brown rhomboid crystals can be seen. Sometimes, false negative tests can also be seen if stain is contaminated or it is very old.
- 3. Spectroscopic Examination:** This is a very reliable test. In this, absorption spectra of stain is prepared and compared with

absorption spectra of haemoglobin and its derivatives.

- 4. Chromatographic Tests:** It can be on paper or silica gel thin layer chromatography, and compared with standard tests.
- 5. Electrophoretic Tests:** Electrophoresis of stain extract can be carried out on agar gel for separation of haemoglobin or serum protein. Haemoglobin can be tested by screening test and serum proteins by immunoelectrophoresis.

Species Identification

Once it is identified as a blood stain, next step is to identify whether it is of human or animal origin. It is done by precipitin test.

Precipitin Test

It is based on antigen-antibody reaction. Antihuman serum is obtained by injecting human serum in rabbits. Stain extract is prepared and treated with anti-human sera. A positive reaction is obtained by precipitation and a ring is observed. This is a very specific test and quite reliable. Other tests which can also be used for species identification are gel diffusion, precipitin electrophoresis, isoenzyme methods and anti-globulin consumption test.

Age of Stain

The fresh blood stain is bright red and, is moist and sticky. In 24 hours, its colour changes to reddish brown. After 24 hours it becomes dark brown. After passage of weeks it may look black.

Whether Stain is Caused by Ante-mortem or Post-mortem Blood

Since clotting is observed in ante-mortem blood only, a fibrinous network due to clot formation can be seen in stains due to ante-mortem blood. This clot formation and fibrinous network would be absent in stain due to post-mortem blood.

Examination of Seminal Stains

Seminal stains are important next only to blood stain. Seminal stains are seen in sexual offences like rape, sodomy, bestiality, etc.

1. **Visual Examination:** Seminal stains may be seen on undergarments of victim/accused in case of rape, or on other clothings like *salwar*, shirt, etc. On visual examination they appear as translucent or opaque spots and a bit stiff on clothes where absorption of semen can be there. If these stains are seen under ultraviolet light, they appear fluorescent. In fresh sample, characteristic disagreeable smell can be appreciated.
2. **Microscopic Examination:** The purpose of microscopic examination is to detect spermatozoa. This is very useful in cases of fresh stains as parts of spermatozoa can be appreciated easily. First, the seminal stain is treated with hydrochloric acid and water, and then the extract is transferred to microscope slides. The slides are stained with haematoxylin and eosin, and then examined under microscope to look for spermatozoa. If spermatozoa are seen, this is a confirmatory test.
3. **Chemical Tests:** The following are the chemical tests usually employed:
 - (a) **Florence test:** A portion of the seminal stain is treated with hydrochloric acid and water to make extract, which is then transferred to a microscope slide. A drop of reagent comprising potassium iodide is put on slide and allowed to mix slowly. Dark brown crystals of choline periodide which are needle shaped, can be seen within a few minutes.
 - (b) **Acid phosphatase spot test:** A seminal stain extract is made and placed in a cavity of porcelain tile. It is then treated with solution of disodium phenyl phosphate. After enzymatic reaction by acid phosphatase present in seminal stain, phenol is liberated which is detected by adding solution of phenol reagent and sodium carbonate. Blue colour develops within 10 minutes indicating presence of acid phosphate in the stain.
 - (c) **LDH isoenzyme method to detect spermatozoa:** In this, LDH isoenzyme bands are made which give specific biochemical reaction to spermatozoa. This test is very useful when seminal stain is mixed with other stains like saliva, vaginal fluid, etc.
 - (d) **Acid phosphatase isoenzyme method:** This method is very specific for semen discharge where spermatozoa are absent due to oligospermia, azoospermia and vasectomised individuals. Even in normal cases this method is quite useful.
 - (e) **Zinc test:** The concentration of zinc in semen is unusually high. Some reagents like pyridylazonaphthol (PAN) which gives bright coloured product with zinc in semen can be used to identify semen. Even zinc can be quantitatively assessed by atomic absorption spectrometer in laboratory. This test is quite useful even in old samples as zinc degrades slowly.
 - (f) **Barberio's test:** A prostatic gland secretion, spermine is present in the semen which can be detected with picric acid with which it forms yellow needle-shaped crystals of spermine picrate.

OTHER TESTS

Besides the aforementioned tests, other tests used for examining seminal stains are as follows:

1. **Electrophoresis:** By electrophoresis, acid phosphatase and LDH-X isoenzyme of semen can be separated by polyacrylamide gel electrophoresis and hence confirmation of semen can be done.

2. **Immunological Methods:** Specific antigens present in human seminal plasma which are called 'sperm coating antigen' can be detected on sperm cells and in the ejaculated fluid by immunological methods. The common antigens are P-30 (prostate-specific antigen)/MHS-5 (comes from epithelial cells of seminal vesicles). Such antigens can be detected by immunological tests like immunodiffusion, enzyme-linked immunosorbent assay (ELISA) and other tests.

Identification of Species of Seminal Stain

This is very essential in cases where bestiality is alleged, as semen may be mixed with other body fluids of animals. The species identification can be done by :

1. **Microscopic Method:** The spermatozoa of human being can be easily differentiated from animal spermatozoa.
2. **LDH Isoenzyme Method:** Specific bioenzyme bonds made in this system give different patterns in animals and humans, and thus offer a method for differentiation.
3. **Immunological Method:** The precipitin test with anti-human serum can be effectively used for seminal stains too, as it is used for blood stains.

Individual Identification of Seminal Stains

The seminal stains can be subjected to group tests like ABO, Rh, MNS, etc. similar to that done for blood stains to identify a person. DNA fingerprinting can be done easily from spermatozoa present and their identity can be established easily.

Examination of Salivary Stains

Saliva is a secretion from the salivary gland which contains enzymes like ptyalin (alpha amylase), glucose-6-phosphate dehydrogenase, along with lipids, chlorides, etc. Salivary stains may be seen in sexual offences on various parts of human body like breasts, face, vagina, etc. In other crime

conditions it may be present on cigarette bits, cigars, etc. The detection of saliva is based on the presence of amylase. In the test, stain extract is brought into contact with starch, which produces reducing sugars which, in turn, are identified by using silver nitrate or triphenyl tetrazolium chloride reagents. The detection of species, and individual identification by various ABO grouping can be done on blood stains and seminal stains.

Examination of Hair and Fibre

Hair and fibre are commonly found in cases of assaults, sexual offences, bestiality, etc. They may be found on human body or at the scene of crime.

Anatomy of Hair

Hair comprises mainly two parts— shaft is the part above the skin, and root lies below the skin. The root has a bulb as a base, embedded in hair follicle. The cuticular scales cover the shaft. The shaft has two layers : outer one is called cortex, and the inner one medulla. Pigment of hair are present in the cortex. The cuticular scales present around the cortex are non-nucleated cells originating from follicle, and goes for keratinisation. The medulla consists of cylinder-like cells produced by matrix cells. The ratio of medullary diameter to that of the shaft is known as medullary index. The medullary column is present in the centre of the cortex.

The pigment granules present in the cortex consist of melanin. It is made up of several units of monomer, consisting of indole and quinone. It contains amino acids like dihydroxyphenylalanine and tyrosine. The medullary cells contain large amount of glycogen.

Examination of Hair

Macroscopic and microscopic examination of hair is done in the laboratory, to distinguish it from fibre and to ascertain whether the hair is of a human hair or an animal. Salient features to distinguish animal hair and human hair are presented in Table 6.3.

Table 6.3 Differences between human and animal hair

<i>Features</i>	<i>Human hair</i>	<i>Animal hair</i>
1. Cuticular scales	Small, flattened and have irregular margins	Large, projecting and various patterns seen
2. Medulla	Very small, fragmented or discontinuous, even may be absent. Diameter is less than 1/3 of shaft diameter	May be continuous or discontinuous, patterns may be seen. Diameter more than half of shaft diameter
3. Shaft	Diameter ranges 50–150 micron	More than 300 microns, in some cases even less than 25 microns
4. Pigment	Evenly distributed, sometimes rarely absent	May be absent. If present, mostly near medulla

Once it is identified that it is a human hair, effort can be made to find out to which area of the body it belongs to. The characteristics like length, shaft diameter, medullary index, shape of cross-section, etc. are helpful in finding the site of hair (Table 6.3).

Examination of Fibres

Various fibres may be found as physical evidence at the scene of crime. During struggle, a victim may be able to catch some fibres from the clothes of the person assaulting him. Such fibres can be examined in the laboratory and comparison may be made with the clothes seized from the person who assaulted.

Medico-legal Aspects of Death

DEFINITION

Death is defined as irreversible cessation of life. It is classified as somatic and molecular. When the three tripods, brain, lung and heart stop completely, it is called *somatic death*. *Molecular death* occurs about 3–4 hours after somatic death when the individual cells and tissues start dying and the decomposition signs start showing.

MODES OF DEATH

There are three modes of deaths:

1. Coma
2. Syncope
3. Asphyxia

Coma

When death results primarily from the failures of the vital centres of the brain, mode of death is called 'coma'. The following are the causes of coma:

1. Compression of vital centres as a result of effusion of blood in cranial cavity due to injuries, or diseases like hypertension or rupture of aneurysm, etc.
2. Depression of vital centres of brain as a result of centrally acting poisons as opium, barbiturates, alcohol, carbolic acid, etc.
3. Vital centres of the brain may be affected in other conditions like epilepsy, uraemia, hepatic coma, heatstroke, hypothermia etc.

In coma, a person becomes unconscious and lose all reflexes and slowly, as a result of depression of vital centres, respiration and heart beat cease. In post-mortem examination, when the skull is opened, injuries to the brain can be appreciated.

Syncope

When death occurs primarily as a result of heart failure, the mode of death is called syncope. It may be due to following reason:

1. Blood loss as a result of sudden and excessive haemorrhage due to rupture of large blood vessel or internal organs like liver, heart, lungs, spleen, etc. It may be due to rupture of aortic aneurysm or varicose veins. The haemorrhage may be external when the blood flows outside the body or internal when blood accumulates in the body as in a rupture of an organ or fracture of long bones like femur, etc.
2. When heart failure occurs as a result of power loss of the muscle of the heart as in myocardial infarction, myocarditis or cardiomyopathies, etc.
3. Inhibition of heart action may be due to neurogenic shock precipitated by a sudden blow on the head, epigastrium, scrotum, etc. It may be due to sudden fright, embolism or sudden pressure on carotid sinuses. The heart may stop suddenly on drinking a large quantity of cold water in a heated condition.

On clinical examination, there would be pallor on the face, the heart beat faster but weak and the respiratory rate higher but shallow. Slowly, the person becomes unconscious and dies.

On post-mortem examination, the body would be pale in colour. The heart would be contracted and chambers empty. All the organs would be pale.

Asphyxia

When the respiratory function of lungs stops as a result of lack of oxygen, it causes failure of heart and brain as a result of oxygen deprivation. This mode of death is called asphyxia. Asphyxia can be due to:

1. Mechanical obstruction to air passage like impaction of foreign bodies, bronchospasm, suffocation, drowning, etc. There may be external pressure to close air passages like hanging, strangulation, smothering, etc.
2. At higher altitude where oxygen is deficient.
3. In poisoning as with cyanide, there is interference in utilisation of oxygen at cellular level.
4. Penetrating injuries of the chest which causes the collapse of lungs or chest muscles.
5. Pulmonary embolism, tetanus and cold causes asphyxia.
6. Poisons such as strychnine, barbiturates and opium.

Clinical Features of Asphyxia

There are three stages of asphyxia:

1. Stage of inspiratory dyspnoea is when the person is not able to take air inside, causing anxiety, heaviness in head and ringing in ears. The lips become livid, eyes get prominent, blood pressure rises and consciousness is lost within one minute.
2. Stage of expiratory dyspnoea is caused by accumulation of carbon dioxide and lack of oxygen causing faster respiratory rate, convulsions and relaxation of sphincters.

Hands and feet become cyanosed. As a result of increased capillary permeability, there is exudation of fluid in lungs and mouth. This stage lasts for 1–2 minutes and as a result of increased sympathetic and parasympathetic activity, there is increased salivation, increased heart rate and gastrointestinal motility. Urine, stool and semen may be passed out.

3. The stage of exhaustion and respiratory failure lasts for about 2–3 minutes. It is marked by failure of the respiratory and nervous centres, leading to brain damage. The respiratory action stops although the heart may beat for 10–15 minutes more. Finally, heart also stops.

Post-mortem Appearance of Death by Asphyxia

Externally, the face is congested. The lips and nails are livid. Tongue is protruded and may be bitten. Saliva may be seen oozing out of the mouth. In hanging, cadaveric lividity is more marked.

Internally, the mucous membranes of the trachea and larynx would be congested and may contain froth. The lungs would be dark and purple in colour and, on cutting section, exude frothy blood. The right cavity of the heart is found to be full; left cavity empty. The brain is congested and blood is dark coloured. Numerous small petechial haemorrhages commonly called **Tardieu's spots** are seen under the serous membranes of various organs, due to rupture of capillaries caused as a result of increased pressure in them. These are usually round, small, multiple and their size varies from pinhead to small pea. They are usually found under pleural viscera, pericardium, endocardium, thymus, meninges, conjunctivae and epiglottis. They are also seen in other conditions like bleeding disorders such as purpura, bacterial endocarditis or coronary thrombosis.

GORDON'S CLASSIFICATION OF DEATH

This classification is based on the concept of tissue anoxia which brings up death. These may be of the following kinds:

1. **Anoxic Anoxia:** It is produced as a result of:
 - (a) Obstruction in the passage of air into respiratory tract, e.g. in suffocation, smothering, etc.
 - (b) Obstruction in the passage of air into respiratory tract due to foreign body, choking, drowning, throttling, hanging, strangulation, etc.
 - (c) By external pressure on chest wall, e.g. falling under debris of earth, earthquake, road traffic accident, etc.
 - (d) Respiratory centre failure as a result of narcotic poisoning like alcohol, opium, barbiturates, etc., and electric injuries.
 - (e) By breathing in an atmosphere containing inert gases or other gases.
2. **Anaemic Anoxia:** It is due to reduced oxygen-carrying capacity of blood due to acute poisoning of carbon monoxide, chlorate, nitrates, etc.
3. **Histotoxic Anoxia:** It is due to depression of oxidative processes in tissue, like in acute cyanide poisoning.
4. **Stagnant Anoxia:** It is due to inefficient circulation of blood due to traumatic shock, heatstroke, acute irritant and corrosive poisoning.

All these types of anoxia produce circulatory failure leading to death.

SUDDEN DEATH

If a person dies within 24 hours without suffering from a recognisable cause, the likely reason for death, his death would be called a 'sudden death'. Most of

these deaths occur by natural causes but obvious etiology is not known at that time. All such cases which are brought before a doctor should not be certified as a natural one, till all the other causes like trauma, poisoning or assault have been ruled out.

Causes

The natural causes of death are:

1. Diseases of Cardiovascular System:

These constitute the majority of sudden death like myocardial infarction, hypertension, acute myocarditis due to infections like enteric, diphtheria, ischaemic heart disease, sub-acute bacterial endocarditis, rupture of aneurysm, angina, left ventricular failure, congenital abnormalities like Fallot's tetralogy or patent ductus arteriosus, occlusion of coronary arteries due to thrombosis/embolism or atherosclerosis, right ventricular failure due to lung diseases, cardiomyopathies, etc. (Fig. 7.1).

2. Diseases of Respiratory System: Diseases producing asphyxia like acute oedema of

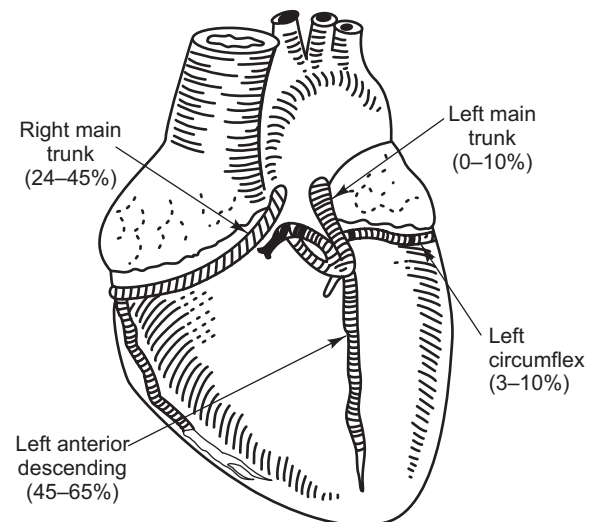


Fig. 7.1 Common sites of occlusion in coronary arteries.

glottis, membrane deposit in larynx or tumour pressing on trachea, spasm of vocal cords, etc. can result in sudden death. Other respiratory reasons are air embolism, rupture of emphysematous bullae or tubular cavity, haemothorax, pneumothorax, hydrothorax, carcinoma of lung, asthma, pneumonia, acute bronchitis, and acute regurgitation of stomach content into lungs in comatose conditions, etc.

3. **Diseases of Alimentary System:** It includes hematemesis due to oesophageal varices, peptic ulcer, carcinoma of stomach or oesophagus, perforation of peptic ulcer, peritonitis, acute gastroenteritis, acute pancreatitis, bursting of liver abscess, rupture of enlarged spleen, strangulated hernia, obstructive cholecystitis, drinking of a large quantity of water in heated condition, etc.

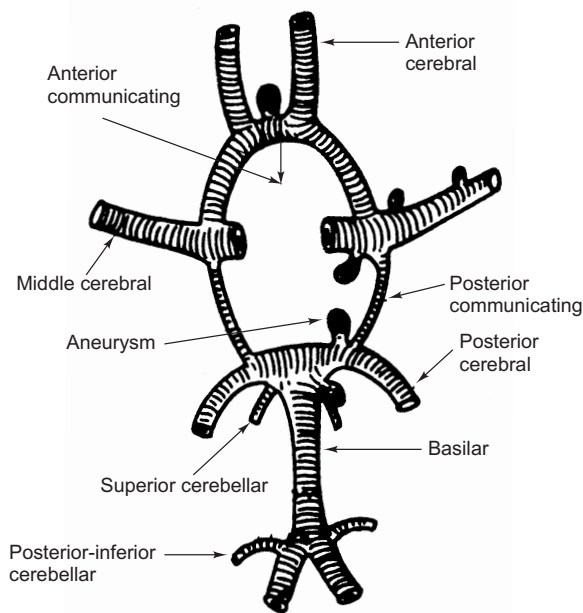


Fig. 7.2 Circle of Willis and frequent sites of aneurysm.

4. **Diseases of Central Nervous System (CNS):** Hypertension or atherosclerosis causing haemorrhage in various parts of the brain like cerebrum, pons, or internal capsule is the leading cause of sudden death due to diseases of the central nervous system. Other causes are brain abscess, acute meningitis, tuberculoma, encephalitis due to bacterial or viral infections, encephalopathies, epilepsy or brain tumours (Fig. 7.2).

5. **Diseases of Genitourinary System:** Prominent diseases include rupture of bladder due to enlarged prostate, stricture of urethra or malignancy, acute or chronic renal failure due to diseases, electrolyte imbalance, renal diseases, tumours, uterine haemorrhages due to tumours like fibroid or malignant tumours, etc.

6. **Systemic Diseases:** Bleeding disorders, diabetes mellitus, Addison disease, cerebral malaria, convulsions, etc. can cause sudden death.

7. Sudden fright, emotional stress can precipitate neurogenic shock or induce myocardial infarction leading to death.

8. Some diagnostic or therapeutic procedures may induce syncope which may lead to death; common procedures are lumbar puncture, vaginal examination, catheterisation of distended bladder, drainage of fluids from pleural or pericardial cavities, etc.

9. Reflex inhibition of vagus may occur due to sudden impaction of foreign body in larynx.

The most common cause of sudden death in India is myocardial infarction. It becomes difficult for autopsy surgeon to determine the cause of death in such cases if death occurs immediately. The changes which can be appreciated with time in gross features and microscopic examination are described below to pinpoint cause of death as myocardial infarction (Table 7.1).

Table 7.1 Changes with time in myocardial infarction

<i>Time</i>	<i>Gross features</i>	<i>Microscopic examination</i>
0–4 hours	None	None
4–6 hours	Pallor is seen	Hyalinisation, loss of striations, and eosinophilia is seen
6–9 hours	Tigroid appearance of the area looks pale or brownish purple	Necrosis with leukocytic infiltration
9–24 hours	Necrosed region shows yellow border with hyperemia around border	Advanced necrosis. Leukocytic infiltration seen
2–4 days	Necrosed area with yellow border which is dry and firm	Marked infiltration of neutrophils with advanced necrosis
5–6 days	Yellow area becomes broader	Macrophages appear. Removal of necrotic material seen
7th day	Whole area becomes yellow	Fibroblasts and capillaries start coming in the area. Phagocytosis of muscle fibres begins
2nd Week	Periphery appears red	Macrophages start removing dead tissue. Collagen found in periphery. Small infarcts heal completely
3rd Week	Pale grey	Dead tissue removal continues. Collagen becomes prominent. Eosinophils start decreasing
4–8 weeks	Scarring seen as grey or grey-white	Collagen increased, vascularity decreased Eosinophils begin to disappear

Some enzymes studies are also useful. The levels of maleic dehydrogenase (MDH), lactic dehydrogenase (LDH) and succinic dehydrogenase (SDH) are quite important. Triphenyl tetrazolium chloride (TTC) reaction is most important and reliable to establish death due to myocardial infarction.

SIGNS OF DEATH

They may be classified as follows:

A. Immediate Changes

Permanent cessation of circulation and respiration.

B. Early Changes

1. Changes in eye
2. Changes in skin
3. Cooling of body
4. Post-mortem staining

C. Late Changes

1. Rigor mortis
2. Putrefaction
3. Adipocere
4. Mummification.

Immediate Changes

Permanent Cessation of Circulation and Respiration

Ordinarily, after death there is permanent cessation of circulation and respiration. This is usually ascertained by examination with stethoscope when one cannot hear any breath sounds or heart beat. Ordinarily, life is not compatible if there is no respiratory or heart beat for more than 5 minutes. In the hospital usually 5 minutes of flat ECG line is considered as stoppage of circulation.

But in some cases, a person may be in suspended animation where respiratory and circulatory activity may be at such low pace that it cannot be detected by stethoscope. Such a stage is seen in trance, yoga, hysteria, epilepsy, cholera, drowning, electrocution, tetanus, cold exposure, poisoning by narcotics, surgical shock and anaesthesia. In such cases, a person can be revived by artificial ventilation and cardiac massage. Some animals like frogs go for such stage for a longer time and it is called 'hibernation'. So, to be sure, one has to apply the following tests to know if circulation has stopped or not:

1. **Magnus Test:** A ligature is tightly applied around the base of finger sufficient to cut venous flow but not arterial flow. The finger remains as such if the circulation has ceased. While if a person is having circulation, the portion beyond ligature becomes blue and swollen.
 2. **Diaphanous Test:** If a person is alive, the webs of fingers appear very red and translucent if the hand is held in front of light with fingers abducted. But it appears yellow and opaque after death. But in carbon monoxide poisoning it may appear red, and yellow in anaemia.
 3. **Icard's Test:** In this, a solution of fluorescein dye is injected into hypodermis. It produces discolouration of skin only if the circulation is there, otherwise not.
 4. If the pressure is applied and later withdrawn on finger nail, it produces, alternately a white and pink colour in live person, otherwise not.
 5. If a small artery is cut, there would not be flow of blood in jerks if the person is dead.
 6. On application of heat to the skin in a living person it produces a true blister with a clear red line; in dead persons, red line would be absent.
 7. If there is no activity on ECG continuously, circulation may be supposed to be stopped.
- The following are the tests for determining the stoppage of respiration:
1. A mirror is held in front of open mouth and nostril. If it gets hazy, it means respiration is there. This test is more useful in cold weather.
 2. If a feather or cotton fibre is kept in front of the nostrils, there would be movement of this if the person is respiring, otherwise not. This test is not much reliable as movement may be there due to air current.

Indian Criteria of Brain Death

Death has been defined as total and permanent cessation of all the vital functions; a state of the

body showing complete loss of sensibility and ability to move in which there is complete cessation of functions of the brain, heart and lungs, the so-called “tripod of life”, which maintain life and health. In majority of cases, death is not an event, it is a process; various organs and systems supporting the continuation of life fail and eventually cease altogether to function, successively and at different times. Rarely, death may occur instantaneously or near instantaneously as in cases of massive trauma. Generally, a dying patient passes through the processes of successive organ system failure reaching an irreversible state at which brain death occurs and this is the point of no return. In some cases, brain death does not occur as a result of the failure of other organs and systems but as a direct result of severe damage to the brain itself. Brain death results in cessation of spontaneous respiration followed by cardiac arrest within minutes due to hypoxia. Whatever the mode of its production, brain death represents the stage at which a patient is truly dead, because by then, all functions of the brain have permanently and irreversibly ceased. Since the respiration and heart can be artificially maintained even after brain death it is necessary that we must define the criteria which will identify with certainty the existence of brain death.

The concept of brain death is in consonance with scientific findings and is critical for the purposes of removal and transplantation of human organs. The traditional concept based on cardio-respiratory failure is scientifically inadequate and redefinition is essential for scientific purposes, as well as for purposes of facilitating organ transplantation.

During the past few decades, brain-related criteria in defining death have gained increasing scientific support, statutory recognition and judicial approval in many parts of the world. With the passage of Transplantation of Human Organs Act, 1994, India has also given statutory sanction to the concept of brain stem death. The act defines the “deceased person” as a person in whom permanent disappearance of all evidence of life occurs

irrespective of the immediate cause, whether brain stem death or cardio-pulmonary arrest any time after live birth has taken place. Brain stem death has been defined as the stage at which all functions of the brain stem have permanently and irreversibly ceased. The brain stem death has to be certified by a board of medical experts consisting of the following:

1. The registered medical practitioner in charge of the hospital in which brain stem death has occurred.
2. An independent registered medical practitioner being a specialist to be nominated by a registered medical practitioner specified in clause (i) from the panel of names approved by appropriate authority.
3. A neurologist or a neurosurgeon to be nominated by the registered medical practitioner specified in clause (i) from the panel of names approved by appropriate authority.
4. The registered medical practitioner treating the person whose brain stem death has occurred.

Transplantation of Human Organ Act 1994 was enacted in July 1994 and notification was issued in the Gazette of India on 4 February 1995. With this notification the concept of brain stem death has become operational. According to the Act there are certain preconditions which must be fulfilled before certifying brain stem death or brain death. These are:

1. The cause of irreversible brain damage (whether accident or illness) producing non-responsive coma must be clearly established.
2. The following reversible causes of coma must be excluded.
 - (a) Intoxication (alcohol).
 - (b) Depressant drugs such as barbiturates, benzodiazepines, meprobamate and methaqualone, etc.

- (c) Muscle relaxants (neuromuscular blocking agent), e.g. succinylcholine.
- (d) Primary hypothermia.
- (e) Hypovolaemic shock.
- (f) Metabolic or endocrine disorders.

The patient must be examined by a board of medical experts twice at an interval of 6 hours and brain stem death will be declared only after observing the following points:

1. Coma—the person is comatose and not responding to any painful stimuli.
2. Absence of spontaneous breathing.
3. Pupillary size—bilaterally dilated and fixed.
4. Pupillary light reflex—absent.
5. Corneal reflexes (both sides)—absent.
6. Doll's eye movement—In a brain dead person the eyes will move with the head.
7. Motor response in any cranial nerve distribution; any response to stimulation of face, limb or trunk; there must not be any response in brain dead person.
8. Gag reflex—must be absent.
9. Cough (tracheal) reflex—must be absent.
10. Caloric test: In a normal individual if cold and warm water is poured in one ear, the eyes will move towards that ear. If there is any abnormality in brain stem the eyes will not move.
11. Apnoea test: The patient is given 100 per cent oxygen through the respirator for 10 minutes and then 5 per cent carbon dioxide is added to oxygen so that there is a maximal stimulus for breathing, followed by passive flow of oxygen at the rate of 6 l/minute through a fine catheter. This procedure allows pCO₂ to rise without hazardous hypoxia. Hypercarbia adequately stimulates respiratory effort within 30 seconds when pCO₂ is greater than 60 mmHg. A 10-minute period of apnoea is usually sufficient to attain this level of hypercarbia. The respirator is disconnected for 10 minutes and the patient is observed for any sign of

respiratory movement. If there is none, the apnoea test is positive. The test is repeated after 6 hours.

The brain stem death certificate has to be signed by all the members of the board, and the organs from the brain dead person can be removed for use for therapeutic purpose after obtaining the necessary consent for such removal.

Death, as defined in the Indian Penal Code (Section 46): Death denotes the death of a human being unless the contrary appears from context and in Registration of Births and Deaths Act 1969 Sec. 29(B)—as the permanent disappearance of all evidence of life at any time after live birth has taken place. These definitions are clearly inadequate and make the task of the medical practitioner extremely precarious and prone to grave legal consequences.

Redefining death in clear and unambiguous term and making operational the concept of brain stem death, will not only permit transplantation of human organs but is also desirable for the following reasons:

1. **Medical:**

- (a) Discontinuance of treatment.
- (b) For optimal utilisation of scarce hospital resources.
- (c) To avoid psychological effects on healthcare workers who were looking after the deceased.
- (d) Provide legal protection to doctors and nurses who are called upon to withdraw support system in case of a brain dead person.

2. **Legal:** For purposes of succession and inheritance.
3. **Social Factors:** To prevent emotional trauma and financial hardship to the members of the family of the brain dead person.
4. **Religious:** For performing last religious rites.

Recognising brain stem death is a step forward and is in consonance with modern concept.

Early Changes

Changes in Eye

Immediately after death, corneal reflex is lost and the cornea becomes opaque. The pupils react to atropine till about an hour after death. The eyes appear sunken due to reduction in intra-ocular tension. The retinal vessels show fragmentation of blood columns immediately after death. There is a progressive increase in potassium levels in vitreous humour after death and has been correlated by some scientists with time since death.

Changes in Skin

The dead body assumes a pale colour and ashy white appearance as a result of drainage of blood from small blood vessels. The skin loses its elasticity and does not gape when cut.

Cooling of Body

After death, the body starts losing its heat to environment and slowly acquires the temperature of surroundings. The rate of cooling is not uniform but it can give some indication of time since death. A rough guess may be made of hours after death by following formula:

$$\text{Hour of time since death} = \frac{\text{Normal temperature of the body (37°C)} - \text{Rectal temperature of the body}}{\text{Rate of fall of temperature per hour}}$$

The rate of cooling is also dependent on following factors:

1. **Age:** The bodies of old people and children cool faster than adult bodies.
2. **Condition of Body:** Fat and large bodies cool slowly due to fat which is a bad conductor of heat.
3. **Manner of Death:** The bodies of persons who were suffering from chronic or wasting diseases cool faster than persons dying of violent reasons.
4. **Atmosphere:** If a body is in open air, it cools faster. It also cools faster when in water.

Post-mortem Caloricity

Sometimes, the temperature of a dead body rises for about 2 hours after death, it is called post-mortem caloricity. It is seen in deaths due to sunstroke, cholera, brain stem haemorrhages especially pontine, yellow fever, rabies, meningitis, peritonitis, tetanus, nephritis, poisoning by alcohol and strychnine. This is due to various chemical changes in the body after death or due to bacterial activity in the body.

Post-mortem Staining

It is discoloration of skin as a result of accumulation of blood into the capillaries and small veins in most dependent parts of the body due to gravitation. If the body is lying on the back, post-mortem staining would be seen on posterior aspects of head, ear, neck, trunk and limbs except on the portion of the body which is in direct contact with the ground as weight of the body prevents the underlying vessels to be filled up. In cases of hanging, if the body has been suspended for a long time, the post-mortem staining would be seen on front and back of both the legs. The coagulation of blood normally starts after 4 hours of death. If the body position is shifted within 4 hours the post-mortem staining would shift. But after 4–6 hours, when the blood coagulates, the post-mortem staining gets fixed and is not altered even if the position of the body is changed. Usual colour of post-mortem staining is purple, and it starts developing immediately after death as small patches which in a normal course of nature in 4–6 hours develop on dependent portion. Post-mortem staining is well appreciated in fair individuals.

Sometimes, the colour of post-mortem staining may point toward cause of death. In asphyxial deaths, the post-mortem staining is bluish violet or deep purple while it is cherry red in poisoning due to carbon monoxide or hydrocyanic acid. At times, in burns or cold, cherry red or darker appearance of post-mortem staining is seen.

In poisoning due to potassium chlorate, bichromates, nitrobenzene and aniline the post-mortem staining is chocolate coloured, while it is dark brown in poisoning by phosphorus.

Post-mortem staining sometimes can be confused with the bruises sustained before death. By noting following points one can easily differentiate between them:

1. Bruise or contusion can occur on any part of the body, may take the shape of the weapon, limited in area and involves deeper tissues while the post-mortem staining is seen on extensive dependent parts of the body and involves only superficial layers of skin.
2. Contusion appears to be elevated above the skin and edges are not well defined but post-mortem staining does not appear to be elevated and has sharply defined edges.
3. The colour changes in old contusion may be seen while post-mortem staining has uniform colour.
4. The surface of the contusion may be abraded in some cases while it is not so in post-mortem staining.
5. On being cut, post-mortem staining would be seen in superficial layers of skin while in contusion it would be in deeper layers of skin and even muscles may be involved. In microscopic examination, vital reaction would be seen in case of contusion while it would be absent in post-mortem staining.

The post-mortem staining also develops in internal organs except heart. It may be confused with congestion in an organ. It may be remembered that post-mortem staining in an organ is irregular and is on dependent part while congestion can be uniform and is not necessarily on dependent portion. Inflammatory reaction would be seen in congestion while it is absent in post-mortem staining. The mucous membrane in congestion may be abraded while it is dull and lustreless in post-mortem staining.

Late Changes

Rigor Mortis

The muscles of the body pass through following phases after death:

1. **Primary Relaxation:** Immediately after death, muscle tone is lost as a result of which the lower jaw falls and there is a decreased tension in limbs, ear and all parts of the body. This is called 'primary relaxation'. But at this stage muscles show contraction when electrical current is passed. The entire body becomes flexible. It lasts about 2–4 hours.
2. **Rigor Mortis or Cadaveric Rigidity:** Soon after death, ATP (adenosine triphosphate) synthesis stops. As a result of which the energy which keeps muscles in contraction and relaxation phase decreases. The voluntary muscles are made of fine fibres which are made up of small contractile elements called myofibrils. In myofibrils there are two portions called 'actin' and 'myosin' responsible for the contraction and relaxation of muscles. Once there is a decreased ATP activity, it leads to fusion of actin and myosin elements and it causes muscles to contract permanently resulting in stiffening in muscles. This stiffening is called 'rigor mortis' or 'cadaveric rigidity'.

As a result of stiffening, joints become rigid and it is very difficult to make movement at the joints. The body becomes so stiff that it can be kept on a small stool in prone position.

The rigor mortis follows a definite course. It starts first in muscles of eyelids, muscles of the back of neck and lower jaw, front of neck, face, chest, and upper extremities and then progresses to muscles of the abdomen and lower extremities. It passes off in the same sequence as it has appeared. The small muscles of the finger and toes are last affected by rigor mortis.

Time of onset of rigor mortis is variable. In summer it may take 1–4 hours to develop while in

winter it may take 3–6 hours to appear. The progress of rigor mortis is also variable according to weather conditions. Normally, it takes about 12–18 hours to develop completely and it remains on the body for about the same duration. In the next 12–18 hours, it disappears. So, usual duration of rigor mortis is 36–54 hours.

In cases where death has occurred from exhaustion, or prolonged illnesses, rigor mortis develops earlier and disappears; while in deaths due to asphyxia, apoplexy, nervous diseases, its onset is slow. In cases of strychnine and other spinal poisons, the onset is rapid and duration longer.

In immature foetus below 7 months, rigor mortis does not set in. In children and old people onset is feeble but rapid, while in adults it is slow but well marked.

If the atmosphere is dry and cold, the onset is slow but duration longer as compared to hot and humid atmosphere where onset is fast and duration shorter. In drowning, the rigor mortis comes early and disappears late.

The following conditions simulate rigor mortis:

1. **Heat Stiffening:** When the body is exposed to a temperature above 50°C, it causes coagulation of muscle protein and it results in muscles being hard and stiff, and thus simulates rigor mortis. Due to intense heat as seen in burns, the body assumes an attitude commonly called 'pugilistic attitude' with lower limbs and arm flexed and hands clinched. The whole body is charred. It is due to shortening of muscles as a result of heat.
2. **Cold Stiffening:** As a result of exposure of the body to extreme cold, solidification of body fat produces stiffening of muscles resulting in cold stiffening. In infants, the skin-folds around the neck may simulate ligature mark due to cold exposure.
3. **Cadaveric Spasm:** Sometimes, the muscles of the body pass directly into a stage of contraction after death without passing the

normal early phase of relaxation. This is called instantaneous rigor or cadaveric spasm. It is generally limited to a single group of muscles rather involving the whole body. This occurs in cases where death has occurred at the time when the body was in great muscular exertion and mental excitement. It is common in situations such as that in the battle field, drowning, strangulation, suicide, etc. The exact reason of cadaveric spasm is not known but excess neuronal discharge into particular group of muscles before death is cited as one of the reasons. Medico-legally, cadaveric spasm has great values as presence of weapon, hair, weeds, pieces of clothes, etc. found grasped in hands may indicate towards the cause of death. Cadaveric spasm is an ante-mortem phenomenon and cannot be created after death. Weapon held in a hand where cadaveric spasm is present can be removed only with great difficulty.

3. **Secondary Relaxation:** As the rigor mortis passes by, the muscles become soft and flaccid and do not respond to mechanical or electrical stimuli. The signs of decomposition start appearing more on the body and the body becomes totally relaxed and flaccid and can be put in any position or posture.

Putrefaction

The putrefaction or decomposition or autolysis is a sure sign of death. It is brought about by release of enzymes after death of cells. These enzymes cause digestive action on cells and thus, bring autolysis. This autolysis sometimes occurs in sterile condition like dead foetus in a womb, where it is called 'maceration'. When this autolysis occurs in the open, the bacteria present in the atmosphere also invade the organs and cause putrefaction faster. Common bacteria which produce putrefaction are *Clostridium welchii*, *Bacillus proteus*, *Bacillus cole* and a large number of streptococci and

staphylococci. As a result of these aerobic and anaerobic microorganisms, the whole body starts putrefying very soon and it is finally reduced to inorganic matter in time. The skeletal remains, teeth, hair, nail, uterus, prostrate, etc. resist putrefaction the most.

The colour changes and development of foul smelling gases are the two characteristic features of putrefaction.

Colour Changes

The first external evidence of putrefaction is seen as greenish discolouration of abdominal skin over right iliac fossa and internally it is seen on caecum, under surface of liver and other portions of intestine close to caecum. It is due to presence of a large number of bacteria in the caecum which start their activity immediately after death. So, a greenish patch on the right iliac fossa may be seen within 1–2 hours of death especially in the summer months.

In about 2–4 hours, cornea becomes white and concave. In 12–18 hours, green discoloration spreads all over the abdomen and genitalia. Later, greenish patches start appearing on chest, neck, face, arms and legs. These patches slowly turn to dark blue colour. These patches slowly cover the whole body. At the same time, superficial veins start looking very prominent like purplish red, brown or green streaks resembling marble-like appearance due to colouring matter of red blood cell set free as a result of decomposition. This phenomenon is called 'marbling of veins'.

Foul Smelling Gases

As putrefaction has started immediately after death, the body starts emitting an unpleasant smell as a result of the development of hydrogen sulphide, ammonia, carbon dioxide, marsh gas and phosphorated hydrogen due to activity of bacteria and other microorganisms. In 12–18 hours, the abdominal distension is seen as a result of accumulation of these gases in abdomen. In 48

hours, these gases accumulate in tissues, cavities and hollow viscera in high pressure causing bloating of the body. As a result, facial features are distorted, eyes are forced out and tongue may be protruded. Slowly, the facial features become totally unrecognisable. The penis and scrotum become swollen. These gases form blisters under the skin containing reddish coloured fluid. As a result of decomposition, the injuries like contusion, abrasion and wounds may become unrecognisable and their shapes are altered.

Common flies like house flies are attracted to the body and they lay their eggs especially around natural orifices and wounds. The eggs hatch into maggots or larvae within 24 hours during summer. These maggots crawl into the body through natural orifices and wounds and start destroying soft tissues. These maggots become pupae in 4 or 5 days. In next 4 or 5 days they transform into adult flies. So, by looking at the different stages of life history of flies a rough idea can be made of the time since death.

In 72 hours, rectum and uterus protrude and contents are expelled. The hair become loose and can be easily pulled out. In 3–5 days, sutures of the skull are separated and the brain is drained off. The teeth may become loose and fall off (Fig. 7.3).



Fig. 7.3 Body showing putrefaction.

Colliquative Putrefaction

In 5–10 days after death, the abdomen bursts open. Thorax in children may burst. Slowly the tissues become soft, loose and are transformed into semifluid, thick black mass. It slowly gets detached from bones and the bones are exposed to putrefaction. Slowly, cartilages and the bones are totally destroyed. It may take 2–5 years for the whole body to be completely destroyed.

Factors Affecting Putrefaction

The factors that affect putrefaction can be external and internal:

1. **External Factors:** Putrefaction is fastened up in hot weather as compared to cold weather. Putrefaction is more if humidity is high. If air movements are more, putrefaction is more. In water, putrefaction is delayed. If the body is buried in damp, marshy soil, the putrefaction is more. If the body is with clothes on, the putrefaction is delayed.
2. **Internal Factors:** The bodies of children putrefy early as compared to adults. The bodies of old people putrefy slowly as moisture is less. There is no significant variation in putrefaction of male or female body. Fat bodies putrefy earlier than thin and emaciated bodies. The persons who have died due to septicaemia, chronic diseases, gas gangrene putrefy faster than healthy persons who died because of other reasons. In asphyxial deaths putrefaction is faster. But in chronic poisoning of arsenic and antimony, putrefaction is delayed. In strychnine poisoning, putrefaction is delayed.

Adipocere

Sometimes, the process of putrefaction is altered and is replaced by formation of adipocere, which is a waxy looking substance with greasy feel and may

Table 7.2 Correlation of the time since death with changes in body

<i>Time since death</i>	<i>Changes</i>
Less than 1 hour	Warm body, cornea transparent.
2–3 hours	Rigor mortis seen on face, some patches of post-mortem staining seen on back.
6–8 hours	Post-mortem staining well developed and fixed. The body is cold and the rigor mortis is present on upper parts of body.
12 hours	Rigor mortis present all over the body, slight discolouration on right iliac fossa of the abdomen.
12–24 hours	Rigor mortis present on all over body, post-mortem staining on the back and fixed, greenish discolouration of right iliac fossa and abdomen, eggs of flies seen.
24–36 hours	Greenish discolouration over chest and abdomen, distension of abdomen due to gases, rigor mortis starts decreasing.
36–48 hours	Marbling, distension of abdomen and thorax, maggots present, post-mortem blisters seen.
3–5 days	Whole body bloated, face not recognisable, hairs and nails can be pulled off, pupae seen over the body.
1 week	Internal organs reduce to unrecognisable masses due to colliquative putrefaction.
2 weeks	Soft tissues gone, prostate or uterus still can be identifiable.
1–3 months	Skeleton starts appearing.
2–5 years	Whole body is destroyed.

be of white or slight yellowish colour. It has got a soapy feel and it melts on heating and emits a disagreeable smell. Its specific gravity is less, so it floats on water. It consists of fatty acids like palmitic, oleic, stearic or hydroxy stearic acid. These are formed as a result of post-mortem hydrolysis and hydrogenation of body fats. The adipocere process is initiated by bacteria *Clostridium welchii* in presence of water and bacterial enzyme, and it hydrogenates the body fats into fatty acids.

The adipocere is seen in hot and humid weather and is reported in bodies submerged in water, canals, marshy areas, etc. It starts in subcutaneous fat and spreads to skin, muscles and organs. It starts early in body areas where fat is more, e.g. female breasts, cheeks, buttocks, etc. It may cover all the areas of the body. The adipocere has great medico-legal importance. As the facial features are well preserved,

body can be identified even late. The injuries present on the body can be well appreciated. The presence of adipocere may tell how the body has been disposed off. Time of formation of adipocere is quite variable and it depends on the atmospheric condition and may range from a few weeks to months. It is not necessary that adipocere is to be seen all over the body. In majority of cases, only a part of the body is involved.

Mummification

It is desiccation or drying of the dead body where the soft tissues present on the body shrivel up. In this condition body retains its natural shape and appearance. The skin becomes dry, leathery and is adherent to bones, and is dark brown in colour. The facial features are preserved. The body smells

of old cheese. The internal organs also dry up and may blend with each other. Mummification occurs in dry and hot areas like the desert, or in shallow graves. The time of formation of mummification varies according to atmospheric conditions and may vary from 3 months to one year. The mummification has great medicolegal significance as identification of a dead body is possible even after years. Even the expression at the time of death can also be appreciated. The injuries present on the dead body can be appreciated too. The chronic arsenic and antimony poisoning facilitate mummification in hot and dry condition.

Some cases have been reported in which adipocere and mummification has been seen on the same body.

TIME SINCE DEATH

A doctor should be able to give time since death after conducting post-mortem examination. He

should consider cooling of the body, post-mortem staining, rigor mortis and decomposition. Besides these, examining the contents of the stomach, intestine and bladders can give some useful points (Table 7.2).

The rate of emptying of stomach and identification of food items in the stomach can give some idea about the time of death. The stomach emptying time depends on many factors like consistency of food, as carbohydrate leave stomach early, proteins late and fats in the last. The stomach emptying time is between 2–6 hours. The food items like *dal* or rice can be identified till 4 hours of eating them.

The presence of urine in bladder may give some idea about time since death. The normal urine content is about 1.5 litres/day, 50 per cent of which occurs during sleep. It is a normal habit of most of the people that they empty their bladder before going to sleep, so a large full bladder may indicate that the person has been killed in the morning.

Post-mortem Artefacts

DEFINITIONS

Post-mortem artefacts are defined as any changes caused, or features introduced in the body after death. These are not physiological changes or disease processes.

Ignorance of post-mortem artefacts may lead to wrong interpretation of time since death, cause of death, manner of death, leading finally to wrong investigation and possible, miscarriage of justice. Artefacts are classified as:

Artefacts Due to Decomposition

Decomposition is the single most important reason of post-mortem artefacts. The following are some examples:

1. Swollen lips, nose, eyelids; protrusion of tongue and swelling all over the body may be interpreted as asphyxial death or body being obese.
2. Dribbling of fluids from the nose and mouth due to decomposition may be interpreted as haemorrhage inside.
3. A groove found in the neck in an obese person or due to tight garments may be falsely interpreted as ligature mark in strangulation.
4. Gas bubbles in blood vessels due to decomposition may be perceived as air embolism.
5. Post-mortem separation of sutures in a child due to decomposition may be taken as fracture.

6. Peeling of skin due to decomposition may be confused with burns.
7. Marbling of veins may be confused as long abrasions.
8. Splitting of skin may also be confused as injuries.

As a result of decomposition, alcohol and cyanide may be found in the body. It may give the impression of poisoning. It should be remembered that in such cases, alcohol concentration does not go above 20 mg per 100 ml of blood and cyanides are found in traces only.

Third Party Artefacts

These may due to following reasons:

1. Onslaught of animals, birds and insect on the body may produce lot of artefacts. The injuries caused by animal bites may be mistaken for injuries. Injuries caused by ants may be mistaken for abrasions. Presence of flies on the wounds may alter their size and texture leading to wrong interpretation of instruments causing it.
2. Emergency medical treatment may cause rib injuries, contusions and defibrillator marks on precordium. It may be mistaken for burns or injuries. Intracardiac injection may lead to haemopericardium. Gastric contents may be aspirated in agonal phenomenon and resuscitation may be mistaken. Surgical incisions may be misinterpreted as sharp injuries. Endotracheal or gastric tubes may cause injuries during introduction.

3. **Deliberate mutilation:** Sometimes, even after death, injuries are inflicted which may be due to revenge or to confuse investigative agencies. In such cases, careful examination should be done to know what injuries finally led to death.
4. **Artefacts due to embalming:** Presence of embalming fluid may pose difficulty in ascertaining the cause of death in poisoning cases. Wounds caused by trocar to introduce embalming fluid may be mistaken for injuries.
5. **Artefacts during post-mortem examination:** Opening of skull by a saw may produce more fractures or enlarge existing ones. Pulling of dura mater may cause damage to blood vessels. During neck dissection, cutting of vessels may cause extravasation of blood in tissues which may be mistaken as being due to strangulation. Liver laceration may occur due to forceful handling. While collecting blood samples or cerebrospinal fluid (CSF) sample, contamination with other fluids may be there.

Artefacts Due to Environment

These may appear in the following situations:

1. **Post-mortem burning:** In circumstances where the body is subjected to high temperature as in a desert, the subcutaneous fat may become hard and ruptures may be seen resembling incised wounds.
2. **Post-mortem corrosion:** Dead body exposed to corrosives like kerosene, petrol or diesel may show chemical injuries.
3. **Post-mortem maceration:** If a body has been lying in open environment for a long time, it may show signs of maceration or skeletonization.

Artefacts Due to Various Other Reasons

It may be possible in the following circumstances:

1. Post-mortem staining may be confused with haemorrhage.
2. Due to wrong handling of the body, artefacts may be produced. The injuries like abrasion, contusion, laceration or fracture may occur. Rigor mortis may be broken.
3. Exhumation may also introduce artefacts. Digging tools may cause injury to the body. Post-mortem imbibitions of chemicals present in the soil may cause wrong interpretation on visceral analysis.
4. Artefacts may be introduced if post-mortem is delayed as volatile chemical poisoning may not be detected since its concentration falls.

Asphyxial Deaths

DEFINITION

The word 'asphyxia' means absence of pulsation. But in forensic medicine, it means lack of oxygen. It may be described as interference with respiration due to any cause like mechanical, environmental, or toxic. Anoxia refers to complete absence of oxygen.

CAUSES OF ASPHYXIAL DEATHS

Deaths caused by asphyxia are broadly classified as:

1. Hanging
2. Strangulation
3. Suffocation
4. Drowning

Hanging

Hanging is defined as death produced by suspending the body by the ligature tied around the neck. The constricting force producing asphyxia in this is the weight of the body, or sometimes only a part of the body like head.

Hanging is of two types:

1. **Typical Hanging:** When the body is suspended from a high point of suspension and feet are not touching the ground, it is called 'typical hanging'. In this, constricting force is the full weight of the body.
2. **Atypical Hanging or Partial Hanging:** When some part of the body touches the ground like knees, feet, etc., it is called 'atypical' or 'partial hanging'.

Ligature

Any type of ligature can be used for hanging, common being rope, *dupatta*, *saree*, *dhoti*, bed sheet, handkerchief, wires, etc. The ligature should



Fig. 9.1 See ligature and ligature mark on the neck in a case of death due to hanging.

be inspected for strength whether it can sustain the weight of the body or not. The ligature should be inspected microscopically for tissues present on it from the neck of the person who has hanged himself (Fig. 9.1).

Symptoms of Hanging

Initial symptoms are loss of power and sensation like flashes of light, noise in ears followed by unconsciousness. In judicial hanging, convulsions may be seen. Since the onset of unconsciousness is very fast, hanging may be considered as a painless mode of death. Due to fast onset of unconsciousness, it may not be possible to save oneself in accidental or suicidal hanging.

The heart continues to beat for 10–15 minutes after the respiration stops.

Cause of Death

The following are noted as causes of death due to hanging:

1. **Asphyxia:** This is quite a common cause of death in hanging as ligature blocks the respiratory passage making air entry impossible.
2. **Venous Congestion:** Since the venous supply of the brain is occluded due to constriction of jugular veins, there is congestion in the brain and it stops cerebral circulation due to anoxia.
3. **Combined Asphyxia and Venous Congestion:** It is the commonest cause of death in hanging.
4. **Cerebral Ischemia:** Due to the pressure of ligature on large arteries of the neck, the blood supply of the brain is affected resulting in cerebral ischemia.
5. **Fracture or Dislocation of Cervical Vertebrae:** This usually occurs in judicial hanging due to sudden drop of about 2 metres. As a result, spinal cord laceration may be seen causing instant death. Second and third vertebrae are commonly affected. Pharynx may be found injured in judicial

hanging. Transverse tears on intima of carotid arteries may also be seen.

The point of suspension in most of the cases may not be very high. It has been reported that people have committed suicide in sitting, kneeling or lying positions. Various studies have pointed that 3–5 kg of tension can occlude jugular veins and carotid arteries, while about 16–30 kg of tension is required to obstruct vertebral arteries. Trachea is obstructed by a tension of about 15 kg.

The death is instant in judicial hanging, while in ordinary hanging 3–5 minutes are sufficient to cause stoppage of respiration although heart may continue to beat up to 10–15 minutes. If air passages are not blocked completely, death may occur in 10–15 minutes.

Management of Hanging Case

The first step in management of hanging cases is to remove ligature immediately, preferably by cutting or removing it. Artificial respiration should be given immediately and the person should be shifted to hospital at the earliest where he should be given artificial oxygen and managed conservatively. The person who survives may have hemiplegia, convulsion, loss of memory, or some brain damage.

Post-mortem Changes

The following features should be noticed during post-mortem examination:

1. **External Examination:** The ligature may be seen in the neck. It should be removed carefully by cutting, preserving the knot and both cut ends should be tied with a thread. It should be inspected and its dimensions should be noted. It should be sealed and then handed over to the police.

The ligature mark is usually situated above the thyroid cartilage and is found to be going obliquely upwards following the line of mandible and may be interrupted due to presence of knot. In some cases, ligature mark may be present at thyroid cartilage level or below.

The character of the mark varies according to the nature of the ligature used. The pattern of ligature

Table 9.1 Differences between ante-mortem and post-mortem hanging

<i>Features</i>	<i>Ante-mortem hanging</i>	<i>Post-mortem hanging</i>
1. Motive	Usually suicidal. Homicidal only in cases of lynching.	Motive to disguise as suicide.
2. Ligature mark	Ligature mark well developed, base is parchment-like and is yellow or brown.	No such features seen.
3. Saliva	Dribbling of saliva may be seen.	Absent.
4. Injuries	No other injuries may be seen.	Other injuries which caused death may be seen.
5. Asphyxial features	Will be seen in the body.	No asphyxia signs present.
6. Circumstantial evidence	Closed room. No signs of struggle may be seen.	Signs of struggle may be seen.
7. Drag marks on the body	Not present.	May be seen.
8. Suicide note	May or may not be present.	Never present.
9. Rope fibres	Maybe seen in the hands.	Not seen.

may be present on the neck skin. The ligature mark is like a groove, its base is pale, hard, leathery and parchment-like. The ligature mark is the deepest at the knot. The colour of the ligature mark is reddish brown if the body has been suspended for a long time. Sometimes in a fat person, a pseudo mark may be seen due to presence of skin folds of the neck. In these cases no characteristic marks like parchmentsation would be seen.

The neck is found elongated and stretched. Petechial haemorrhages may be seen on face, neck and under the conjunctiva. The tongue may be seen protruded in some cases. Dribbling of saliva may be seen from the angle of mandible. This is considered as the surest sign of ante-mortem hanging as this is a vital phenomenon and cannot be produced after death, although in a dark skinned person, this sign may be difficult to detect.

Turgescence may be observed in genital organs. Semen may be found at the urethral opening. Due to relaxation of sphincters, urine and faeces may be seen in clothes. If the body has been suspended for a long time, post-mortem staining may be seen in the arms and legs (lower part; Table 9.1).

- Internal Examination:** A curved incision from behind the right mastoid process to the left, extending down up to sternum is useful for careful dissection of neck layer-by-layer

for the best results. A dry, white and glistening subcutaneous tissue is seen underneath the ligature mark. This is typical in death from hanging. The carotid arteries may be found lacerated. The muscles of neck may be found ruptured especially in cases where great force has been used in hanging. The fracture of cervical vertebrae along with rupture of spinal cord may be seen in judicial hanging. Usually, thyroid and cricoid cartilages escape fracture. They may be found fractured if somehow ligature passes on the neck—may be in atypical hanging. Fracture of hyoid bone may be seen in some cases. The epiglottis and mucous membrane of mouth may be ruptured.

The lungs may be congested, oedematous and exude blood mixed serum. The right side of the heart is filled with dark fluid and, due to haemorrhages the left side is empty. The abdominal organs are congested. The brain may show congestion. Petechial haemorrhages may be seen in lungs, heart and abdominal organs.

Medico-legal Importance

The questions normally asked of a doctor in a hanging case are:

1. Whether a person has died of hanging or not?
2. Whether hanging is accidental, suicidal, or homicidal? Sometimes, a person may be killed by other methods like strangulation, fire-arm or stabbing. This body may be put in hanging position so as to create an impression that the person had hanged himself. In such cases doctor should carefully examine the dead body and look for other causes of death. Careful dissection of neck would reveal that the person had died of hanging or strangulation.

Hanging is mostly suicidal in nature. No age bar is there for suicide. Males commit more suicide as compared to females. Major reasons for committing suicide in males are unemployment, family tensions, drinking, etc. The major reasons for females committing suicide are family maladjustment, failure in exams, failure in love life, dowry, etc.

Homicidal hanging is very rare. It is possible that one person is overpowered by a group of persons and forcibly hanged. In such cases, injuries may be seen on the victim who tries to defend himself. Lynching is a form of homicidal hanging which was quite prevalent in old times where a mob used to hang a condemned person by a tree.

Accidental hanging is common among children who may accidentally die because of slippage of stripes of school bag on the neck.

Auto-erotic hanging or sexual asphyxia is a form of accidental hanging. It has been reported that by producing asphyxia with a ligature on neck, sexual stimulation is enhanced in a sexually charged atmosphere. The victims are mostly males. Some soft material like handkerchief or wire may be used by the victim and its pressure is increased by hands or remotely by legs. The victim is usually found naked with pornographic material around him. If he has taken alcohol, asphyxia is rapidly produced. Sometimes, he may not be able to remove pressure

in time and may die. In all such cases, examination of scene of crime is very useful.

Strangulation

Strangulation is a violent form of death which occurs from constriction of the neck by means of ligature or by other means without suspending the body:

1. **Throttling:** It is defined when constriction of neck is produced by fingers or palms.
2. **Mugging:** When constriction of neck is done by a foot, knee, or bend of elbow it is called mugging.
3. **Bans-dola:** It was practised earlier in North India where one strong bamboo is put in front of neck and one on the back. These are tied by rope. The constriction is caused by squeezing. Sometimes, squeezing is done by foot pressure on bamboos.
4. **Garroting:** It was earlier used by thugs while committing robberies. In this a rope or handkerchief is suddenly thrown from behind around victim's neck and pressure is suddenly applied. Since unconsciousness develops suddenly, the victim is unable to fight back and dies silently.

In strangulation, if the air passages are occluded completely by ligature, the person is unable to shout and becomes unconscious immediately. If closure is partial, face may be seen cyanosed, hands may be clenched and convulsions may be seen. The cause of death in strangulation is asphyxia due to anoxic anoxia.

Post-mortem Findings

These are as follows:

1. **External Findings:** Ligature may be seen on the neck. It should be photographed in situ. After removal, it should be preserved and handed over. The ligature mark in most of the strangulation cases is usually found below the thyroid cartilage encircling the entire neck, horizontally placed. Multiple ligatures

may also be seen. The ligature mark may look like a groove, the base may be pale with reddish margin. The pattern of ligature may be seen. Abrasions and contusions may be seen around the ligature mark. In cases of throttling, the marks of thumb and fingers may be seen around trachea. These small bruises are disc-shaped, 1–2 cm in diameter and red initially and may look brown later. Sometimes, clustering of these bruises may be seen. Small linear or crescentic marks may be seen on the neck due to pressure of finger nails, which are quite characteristic of throttling. Struggle marks may also be present on the body such as abrasion or bruises on face, nose, mouth, back of the body, etc. There may be other injuries on the body like fracture, stab, etc. The face may be puffy and cyanosed. The eyes are usually prominent. The conjunctivae are severely congested. The petechial haemorrhages may be seen on the face. The lips may be blue.

Bloody discharge may be seen from mouth and nostrils. The tongue may be swollen, bitten or bruised. The genital organs are congested. There may be discharge of urine, faeces or seminal fluid.

2. **Internal Findings:** The dissection of the neck should be done in bloodless field as blood discharged from neck vessels may give erroneous results. To achieve this, the dissection of neck should be done after removal of brain, lungs and heart so that blood may be drained from neck vessels. The dissection of the neck should be done layer-by-layer as in case of hanging. Extravasation of blood into the subcutaneous tissues under the ligature mark is seen. Underlying neck muscles are usually lacerated. Laceration of sheath of carotid arteries may be seen. The fracture of the cornua of hyoid bone is commonly seen. Fracture of thyroid and cricoid

cartilages is common. Although rarely, fracture of cervical vertebrae may also be seen. The trachea and larynx are congested and frothy mucus may be seen. The rings of trachea may also be fractured. The lungs may be oedematous showing dark fluid on section. Emphysematous bullae may be seen on the surface. The right side of the heart is full and the left empty. The abdominal organs are congested. The brain is also congested and may show petechial haemorrhages.

Medico-legal Importance

The doctor is often asked to opine:

1. Whether cause of death is strangulation or not (Table 9.2).
2. Whether the strangulation is suicidal, homicidal or accidental.

A complete post-mortem examination is essential to certify that death has been caused by strangulation. Natural folds in the neck may sometimes create confusion. Suicidal strangulation is very rare, although it is reported in lunatics. It is not possible for an individual to strangulate himself as once unconsciousness supervenes, the ligature pressure decreases.

Homicidal strangulation is the commonest. Accidental strangulation may occur in factories where accidentally a worker may be caught in moving belts. The children may also be strangled accidentally while playing.

Suffocation

Suffocation is a form of death which results from the exclusion of air from the lungs by means other than compression of neck.

Causes

The following are causes of suffocation:

1. **Smothering:** It is defined as closure of mouth and nostrils. It is quite a common way to kill children as they offer less

Table 9.2 Differences between hanging and strangulation

<i>Hanging</i>	<i>Strangulation</i>
1. Face pale looking, petechial haemorrhages less common.	Face congested, livid, petechial haemorrhages common.
2. Saliva dribbling down the chin seen.	No such dribbling.
3. Neck elongated.	No.
4. External signs of asphyxia not prominent.	Very prominent.
5. Bleeding from nose, mouth and ears very rare.	Quite common.
6. Ligature mark obliquely placed, dry, parchment like, going upward, highly placed in neck.	Ligature mark horizontal, round the neck, low in neck, base of groove soft and reddish.
7. Abrasion and contusion around edges of ligature mark absent.	Quite common.
8. Subcutaneous tissues under ligature are white, hard and dry.	Subcutaneous tissues under ligature are suffused with blood.
9. Injury to muscles around ligature mark rare.	Quite common.
10. Rupture of carotid arteries very rare.	Common.
11. Fracture of larynx and trachea rare.	Common. Hyoid bone also fractured commonly.
12. Fracture dislocation of cervical vertebrae only seen in judicial hanging.	Fracture—dislocation of cervical vertebral rare but can be seen.
13. Injuries on other parts usually absent.	Injury on other parts due to struggle may be seen.
14. Sexual assault not seen.	Evidence of sexual assault may be seen sometimes.
15. Emphysematous bullae seen on lung surface.	May be present.
16. Usually suicidal.	Mostly homicidal.

resistance. A small pillow may be used to apply forcibly to mouth and nostrils. Even old persons and women are killed as their physical strength is quite less than able-bodied men. Accidentally, small children can be smothered if they are overlaid by their mothers or they are hard pressed against breasts while feeding.

2. **Choking:** It is defined as obstruction of air passages from within. It is mostly accidental due to impact of foreign bodies like fish bone, coin, button, roundworms, artificial teeth, etc. The foreign body induces laryngeal spasm, as a result of which the air passages are completely blocked. Even a small foreign body may induce laryngeal spasm killing the person. Certain diseases can also choke a person. Tumours may press on air passages. Vomitus may enter air passages and produce laryngeal spasm.

3. **Traumatic Asphyxia:** When there is mechanical fixation of chest sufficient to cause death, it is called 'traumatic asphyxia'. It may occur in big crowds like in a fair where people may be trampled. Pressure on chest may occur in causing death suddenly in labourers. It may also occur in road traffic accidents, railway accidents, etc.
4. **Inhalation of Irrespirable Gases:** Inhalation of irrespirable gases like carbon dioxide, smoke in building fire, hydrogen sulphide, methane in sewer workers may cause suffocation. Suffocation may also occur if a lot of persons are confined in a small place.
5. **Café Coronary:** It has been reported in many cases that a person sitting in café or bar may suddenly collapse and die. It looks like he had a massive heart attack. But on post-mortem examination, a small bolus of

food or fish bone may be present in respiratory passages indicating that a person has died of asphyxia rather than coronary heart disease. The persons who are drunk are more liable to develop café coronary, as cough reflex is less due to alcohol. The cause of death in all suffocation cases is asphyxia. Death occurs in about 5–6 minutes.

Post-mortem Findings

These involve external and internal examination:

1. **External:** In homicidal smothering, effects produced by forcible closure of mouth and nostrils may be seen in forms of abrasions or contusions around mouth and nostrils. Laceration of lip, broken tooth may be seen. The fracture of nose septum may be seen, along with flattening. Due to struggle, abrasions or contusions may be seen on cheeks, lower jaw, chest, etc. In traumatic asphyxia, fractures of ribs may be seen. The face may be suffused. The eyeballs are prominent and conjunctivae congested. Petechial haemorrhages may be seen. The tongue may be protruded.
2. **Internal:** The foreign body like cloth, mud, coin, etc. may be found in mouth, throat or trachea. The air passages are congested. The lungs are congested and oedematous. Soot particles may be seen up to bronchioles, if a person has died of suffocation in a building fire. The Tardieu's spots may be present on lungs, heart, or other visceral organs. The right side of the heart is full while the left empty. The brain is congested. The abdominal organs are congested.

Medico-legal Importance

The doctor is called upon to depose:

1. Whether cause of death is suffocation or not.
2. Whether suffocation is accidental, suicidal or homicidal.

Presence of foreign body or circumstantial evidence point to suffocation in most of the cases.

The detailed post-mortem examination is essential to establish whether suffocation is the cause of death or not. Suicidal suffocation is very rare but reported in lunatics. Accidental suffocation may occur in children when they swallow a small foreign body like a coin while playing. Accidental suffocation may occur if a person is trapped in a building fire or falls in sewer. The firemen or sewer workers may die while doing their duty due to suffocation. Homicidal suffocation is quite common. The foreign body like cloth may be inserted forcibly in mouth. The pillow is commonly used to kill children, old people or women.

The methods adopted are:

- (a) **Burking:** Burking is a method adopted by Burke and Hare to kill their victims. They used to throw their victim down on the ground and kneeling on chest used to close mouth and nostrils with one hand, and firmly holding both jaws together to block air passages. They used to kill persons to supply dead bodies to medical colleges for dissection.
- (b) **Bans-dola:** In this, the victim's chest is compressed between two wooden planks by the assailants. Fracture of ribs and even laceration of lungs may be seen.

Drowning

It is defined as a form of death which occurs when atmospheric air is prevented from entering lungs due to submersion of body in water or other fluids. To die from drowning, it is not essential that there should be a complete submersion. Even if only face is submerged, death can occur.

Types of Drowning

The various types of drowning are as follows:

1. **Wet Drowning:** It may be in fresh water or sea water. The post-mortem findings are different in both cases.
2. **Dry Drowning:** Sometimes, as water enters the air passages, it induces laryngeal spasm

which leads to complete closure of air entry into lungs. As a result of this, water does not reach lungs. The characteristic features of drowning are absent.

3. **Secondary Drowning:** It is when death occurs after sometimes when a person is rescued from being drowned. Death may occur due to aspiration, pneumonia or electrolyte imbalance.
4. **Immersion Syndrome (Cold water drowning):** Sometimes when a person is dropped into cold water, skin receptors are activated immediately. Consequently, sudden dyspnoea and sometimes vagal inhibition occurs. As a result of which heart stops immediately.

The person dies suddenly and classical picture of drowning does not appear. However, in some cases, sudden ventricular fibrillation has also been reported.

Mechanism of Drowning

When a person jumps into water or is thrown into it, he sinks to the depth in proportion to the momentum of his fall, but as a result of buoyancy and struggling movements, he comes to the surface. If he is not a swimmer, he cries for help and struggles to keep mouth above water level. But since the body is heavy, he starts going downwards. During this process, water enters into his respiratory passage and induces coughing. The water enters the lungs and replaces air. As a result, the body becomes heavier and goes down further. Due to movements of hands and feet, he may rise further and take more water into lungs. This alternate rising and sinking continues till he becomes unconscious, or all the air in the lungs is replaced by water. Due to unconsciousness that has set in and weight of the body, he sinks deep to die.

In fresh water drowning, water being hypotonic is absorbed into the lungs immediately and enters pulmonary circulation. As a result there is haemodilution, increase in blood volume and the concentration of sodium/potassium falls. There is

haemolysis of red blood cells. As a result of which potassium concentration goes up in blood and sodium concentration relatively falls due to haemodilution. Increased potassium causes ventricular fibrillation leading to fall in blood pressure.

In salt water which is hypertonic, when the water enters into the alveolar spaces, it draws more fluid leading to pulmonary oedema. It causes haemoconcentration and hypovolaemia. There is no haemolysis and no ventricular fibrillation. Death occurs in more time (8–9 minutes) as compared to fresh water (5–6 minutes).

Symptoms of Drowning

When a person dies of drowning he encounters same types of feelings as that of hanging. There may be hallucinations and recall imagery before onset of unconsciousness.

Cause of Death

In drowning, death occurs due to following reasons:

1. **Asphyxia:** It is the commonest cause of death in majority of the cases.
2. **Vagal Inhibition:** It may be seen in some cases in cold water drowning.
3. **Concussion:** It may occur if a person's head strikes against some hard object inside water. If a person falls flat, even the impact of water may be there on chest to cause concussion.
4. **Syncope:** It may occur in epileptics suddenly falling into water.
5. **Cerebral Haemorrhage:** It may occur in a hypertensive person or whose cerebral vessels are diseased.
6. **Exhaustion:** The person may die from exhaustion in order to keep himself above the water.
7. **Injuries:** The person may die because of injuries sustained while in water, like head injury if struck against hard surface. Fracture, dislocation of cervical vertebrae may be there if a person falls into water from a height.

Fatal Period

Asphyxia starts within 2 minutes of submersion. Death occurs in about 5 minutes although heart may continue to beat for 10 minutes. If the water is cold, death occurs early.

Post-mortem Findings

The external and internal post-mortem findings are as follows:

1. **External:** The clothes may be wet if examined early. The face is usually pale, eyes are open or closed, the conjunctivae are congested and pupils are dilated.

The tongue may be swollen and protruded. A fine, white, lathery tenacious froth is seen at the mouth and nostrils. It increases on compression of chest. It is regarded as a diagnostic sign of drowning. Sometimes, grass or weeds or leaves may be seen clasped in the hands of deceased due to cadaveric spasm.

The special external findings sometimes observed in cases of drowning are as follows:

- (a) **Cutis anserina (Goose skin):** The granular and puckered appearance of skin may be seen on front surface of body especially on limbs in winter season due to contraction of the involuntary muscle (erector pilae) of the skin. The contraction elevates the hair follicle and makes hair stand. This phenomenon is not diagnostic of ante-mortem drowning. It may be seen in nervous shock, violent accidental deaths or may develop after death as a result of rigor mortis of erector pilorum muscles.
- (b) **Washerwoman's hand:** The skin of hands and feet may show a bleached, corrugated and sodden appearance due to prolonged stay of the body in water (10–12 hours). It is called washer

women's hand. It only shows that the body has been in water for considerable time. It has no relation with the cause of death.

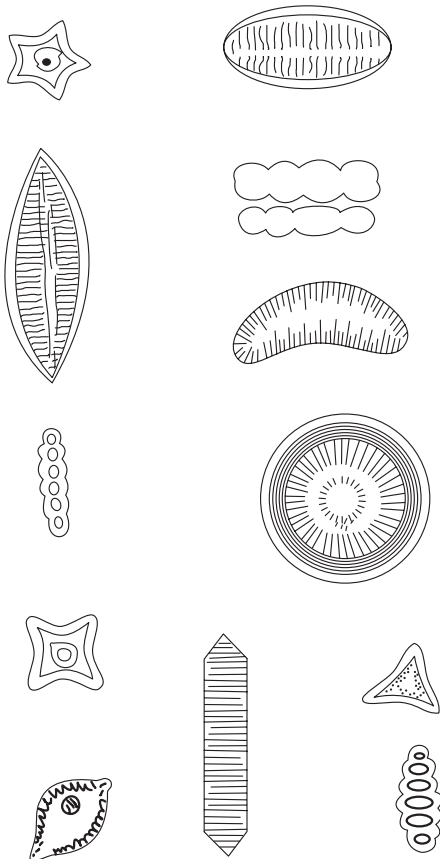
The rigor mortis appears early in cases of drowning. The penis and scrotum may be retracted and contracted if water has been cold.

2. **Internal:** The chest findings are quite typical in drowning. The lungs are distended like balloons. They overlap heart and may protrude out of chest wall when it is opened. Lungs may be indented with rib marks. They are heavy, doughy to feel, grossly oedematous and may pit on finger pressure. Large patches of haemorrhages commonly called **Paltauf's haemorrhages** may be seen subpleurally. They occur due to increased pressure causing rupture of alveolar walls. Usually, they are present on anterior surface and margins of lungs. Petechial haemorrhages, which are small may be seen on lungs, but they are quite uncommon in drowning. On section, frothy fluid mixed with blood may exude from the cut section. Fine froth may be seen in trachea and bronchial passages. The left side of the heart is usually empty and the right side full. The brain is congested. A large quantity of water along with small weeds may be seen in stomach and small intestine. This is a very important sign as it can only be produced in ante-mortem drowning (Table 9.3). The internal organs are congested.

Gettler's Test: This is a laboratory test done where difference in concentration of chlorides, magnesium (sea water drowning), specific gravity of blood of two chambers of heart is compared to diagnose drowning. In fresh water drowning, the concentration of chlorides in blood of right side of heart would be less as compared to left, while in sea water drowning, the concentration of magnesium would be more in right side of heart.

Table 9.3 Differences between ante-mortem and post-mortem drowning

Features	Ante-mortem drowning	Post-mortem drowning
1. Froth	Fine, leathery froth present at mouth and nose.	No froth seen.
2. Lungs	Bloated, overlap heart, indented with rib marks, doughy to feel, grossly oedematous.	Water may be seen in lungs.
3. Cadaveric spasm	Weeds may be seen in hands.	Not present.
4. Injuries	Usually not present. Head injury or other injuries may be seen if person hit them.	Injuries resulting in death from other reasons may be seen.
5. Asphyxial findings	Will be seen.	Signs of death from other reasons may be seen like shock/coma etc.
6. Motive	Usually accidental or suicidal. Homicidal mostly in children or old people.	Mostly homicidal. Death to be disguised as accidental or suicidal.

**Fig. 9.2** Various types of diatoms.

Diatom Test: Diatoms are a class of unicellular algae varying in size from 2 micron to a millimetre, found in fresh water and sea water. There are about 15,000 types of diatoms.

They are varying in shape. They have a siliceous, very hard covering and they can pass alveolar walls and hence can reach to any part of body via circulation. Finding of diatoms on microscopic examination from brain, lung, liver, bone marrow can suggest that the person has died of drowning. The types of diatoms recovered from the body can be matched with diatoms present in water for more logical conclusion of drowning. The diatoms are isolated by **Acid Digestion Technique**. The concentrated sulphuric acid is used for digestion of tissue, after which it is centrifuged and examined for diatoms. The test site to examine diatoms is bone marrow from long bones like femur, humerus, tibia or sternum. Brain tissue and lung tissue are also good sites for looking for diatoms (Fig. 9.2).

Medico-legal Importance

The doctor is often asked:

- (a) Whether death is caused by drowning.
- (b) Whether the drowning is accidental, suicidal or homicidal.
- (c) Duration of the body in water.

Whether death is caused by drowning: A careful post-mortem examination should rule out foul play in most of the cases. The doctor should look for any injuries on the body which may show application of force on the body. The following points go in favour of death due to drowning:

- (i) The presence of profuse fine, lathery froth which increases on pressure on chest.
- (ii) Cadaveric spasm in hands holding some weeds.
- (iii) The typical chest picture of drowning seen in lungs when opened on dissection.

- (iv) The presence of water, mud, weeds in stomach and small intestine.

Whether drowning is suicidal, accidental, or homicidal: Mostly, drowning is accidental but suicidal drowning is also very common. Females constitute a high number who commit suicide by jumping into village wells.

Homicidal drowning is rare except in cases of infants or small children who can be thrown into water.

Duration of body being in water: As the body is heavy, it starts sinking into the water and does not come out till putrefactive change starts and presence of a large amount of gas makes it float. In warm water, the putrefaction is faster so floatation is early reported as compared to cold water.

Death from Starvation, Cold and Heat

STARVATION

It may be acute or chronic:

1. **Acute Starvation:** It is defined as sudden deprivation of food from the body. In some cases, even water is withdrawn. This situation mostly happens in famine, or natural disasters like earthquake when a person is trapped in debris or in floods. Acute starvation also happens in political workers, who go on fast-unto-death to achieve political goals. It is also reported in religious fastings.
2. **Chronic Starvation:** In India, chronic starvation is common in poor people who eat less due to unavailability of food. Children are most affected.

Clinical Features of Acute Starvation

The feeling of hunger remains for about 2 days and then is replaced by pain in epigastrium with intense thirst. The pain may be a bit relieved by pressure. After 4 or 5 days, the body fat starts decreasing and general emaciation sets in. The eyes appear sunken, buccal fat disappears, face looks dry, and breath turns foul. Slowly the voice becomes slow, pulse is weak, and body temperature becomes sub-normal.

The abdomen is sunken. The limbs become thin. There is a generalised loss of muscle power.

Initially, there is constipation but later diarrhoea may start. The urine becomes less and shows features of acidosis like ketone bodies.

The consciousness and intellect remains clear till the end as brain tissue is least affected due to starvation. But in the end, the person may pass into coma and die. Delirium and convulsion may be seen before death.

Clinical Features of Chronic Starvation

It may have dry or wet type of picture. In dry one, gross emaciation is nearly all over the body. The person may be having diseases due to low immunity. In wet type, oedema may be seen all over the body. Pleural effusion may be seen. Usually, a person is found to be anaemic. The fatal period in chronic starvation is quite variable. If both food and water is withdrawn, death may occur in 10 days. If only food is withdrawn, person may survive for some weeks as long fasting up to 6–8 weeks have been reported by religious saints. The effect of chronic starvation on children is very severe. Old people can survive starvation for a longer time as their requirements are less. Females can withstand starvation better than males due to the presence of more fat in the body.

Healthy people can bear starvation better than persons who are diseased. Active physical activity enhances death in starvation. Starvation in extreme temperatures also enhances death.

The person who is suffering from starvation should be treated carefully. The food should not be rushed orally as intestines have gone weak. Initially, fresh juice may be given and later solid food may be introduced slowly. Intravenous drip of glucose should be started immediately and monitored well. The person should be kept in warm temperature and electrolyte imbalance should be corrected at the earliest.

Post-mortem Findings

These include external as well as internal features:

1. **External:** The body appears grossly emaciated, skin is dry and shrivelled. Eye-balls are dry and sunken. The body may emit a bad smell. The muscles are soft and wasted. The fat is almost absent from various parts of the body like abdomen, breasts, hips, etc.
2. **Internal:** The internal organs appear contracted. Fat in subcutaneous tissue may be absent. There may be ulcers in the stomach and small intestines due to stress of starvation on the body. The intestines are empty and contracted. The normal organs may be pale. The brain appears normal.

Medico-legal Importance

The acute starvation is usually accidental, like in natural calamities, e.g. in earthquake, building collapse where people may be trapped.

Starvation may be rarely suicidal except in some persons who under the influence of insanity may starve to death. Willful starvation to achieve political or religious goals is quite common. In these situations, the medical officer is often confronted with a dilemma whether forceful feeding should be started on direction of civil authorities or not. Since in such cases, the person remains conscious till the end, it may be ethically wrong to feed someone forcefully against his/her wishes, and is also unlawful. But if the person becomes unconscious, feeding can be done to save his/her

life. Feeding should be suggested to a person who is under willful starvation, when ketone bodies appear in urine. He should be explained the impending danger. Homicidal starvation can be seen in small children or old persons who can be starved to death by confining them in their houses.

COLD

Effects of Cold on Body

When a person is exposed to cold it induces extreme vasoconstriction, a protective mechanism for maintaining correct body temperature. It conserves body heat by reducing blood supply to exposed areas. But if exposure to cold is high, it leads to ice crystal formation intra- or extracellularly, which causes immense damage to cells. Severe cold also causes injury to small blood vessels with formation of agglutinative thrombi in them. But if the person who is exposed to cold is suddenly exposed to heat, he will face overheating metabolically and he can suffer damage.

Fatty tissues and myelinated nerve fibres face direct effect of exposure to cold. Vascular damage leading to ischaemia is also seen.

Frostbites

When the body is exposed to freezing temperature (-8°C to -10°C), erythematous patches appear on skin which are caused by impaired local circulation, injury and shock. The frostbites are both, superficial and deep. Superficial frost bites involving skin and subcutaneous tissues have soft blisters in 24–36 hours. These blisters become black and hard in 2 days. Deep frostbites are quite serious as they involve deep tissues up to bone. Blisters appear later in 3–7 days. There may be marked sloughing of tissues. Exposed parts of the body like nose, eyes, ears, fingers and toes are usually affected due to cold. If a person has been in cold water for a long time, it produces a phenomenon called ‘immersion

foot' or 'trench foot'. This may be seen in survivors of shipwreck. The frostbite phenomenon is a vital reaction and hence cannot be produced after death.

In general, moderate cold is good for health. It recharges the body and improves metabolism. But if the body is not properly clothed and is exposed to severe cold, it causes stiffening of muscles. Hypothermia sets in and the person dies. The death occurs due to less supply of oxygen to tissues and brain tissue as haemoglobin is unable to part with oxygen due to low temperature. The using capacity of tissues is also reduced. The person may develop ventricular fibrillation.

Treatment

Immediately the person should be shifted away from the cold. His clothings should be removed and new warm clothes should be given. The person should be warmed by hot water bottles or warm water. Some soft rubbing with hands may be done. Direct heating of the person should not be done. Blisters should be handed properly. The person should be treated conservatively.

Post-mortem Findings

It includes external and internal features:

1. **External:** Frostbites are characteristically seen as pale, irregularly margined, dusky red patches on exposed parts. Rigor mortis is delayed. The body may be quite cold.
2. **Internal:** The internal findings are not specific. The organs are found to be congested. The blood may appear bright red owing to non-dissociation of oxygen from haemoglobin. Sometimes, ice crystals may be seen microscopically in capillaries. Stress ulcers may be seen in stomach and intestine.

Medico-legal Importance

The death due to cold is usually accidental. It may be seen in small children, old beggars and drunkards

who may die when exposed to cold while sleeping on streets. Small infants can be exposed to cold if thrown over streets with an intention to kill them.

HEAT

Effects of Heat

The heat on the body causes sweat and peripheral vasodilatation. The effects of heat on body are classified as following types:

1. **Heat Exhaustion:** The sweating induced by heat causes dehydration and electrolyte loss. The person feels giddy, may have headache, malaise and may fall down. He may feel very thirsty, along with cramps in legs. He may have oliguria. He may collapse later. In some cases, the person may collapse suddenly without symptoms and die.
2. **Heat Syncope:** In this, the person collapses as a result of hypotension induced by heat.
3. **Heat Fatigue:** The performance of a person may start decreasing due to exposure to heat. He may feel fatigued and less motivated for work.
4. **Heatstroke:** It is also called 'heat hyperpyrexia' or 'sun stroke'. It may be seen in workers who have been working in the sun in high temperature for a long time. In such cases, symptoms appear suddenly and the person may collapse suddenly. In such cases, sweating is absent and body may show higher temperature (hyperpyrexia). Pupils may be dilated and face may be flushed. In some persons, symptoms appear to start slowly. Initially there may be profuse sweating, extreme thirst, confusion, headache, hypotension and pupils may be dilated. Slowly, sweating stops and temperature of body starts rising and the person becomes unconscious.

5. **Heat Cramps:** In workers who are working in the sun or heated atmosphere, cramps start occurring in legs as a result of sweating causing loss of electrolytes, especially sodium. Cramps may occur in hand or fingers.

Treatment

The person should be immediately removed from the heat. He may be given water to drink. Electrolyte balance should be corrected by giving salted water. In order to cool the body, hydrotherapy should be started immediately. Fluids

should be started intravenously to correct fluid imbalance.

Post-mortem Findings

Rigor mortis starts early and passes off early. Sweating may be absent. The body is dry and may show higher temperature initially. Petechial haemorrhages may be seen. Internal organs are found to be congested.

Medico-legal Importance

Most deaths occurring due to heat are accidental, as in construction workers or industrial workers.

Injuries from Burns, Scalds, Lightning and Electricity

BURNS

Definitions

Burns are defined as injury caused to the body by the application of dry heat like flame, heated material or radiant heat.

Scalds are wet heat injuries produced by application of heated liquid or its gaseous form like steam. Scalds are usually not so severe as the liquid or gas runs off from the surface (Table 11.1).

Medico-legally speaking, injuries caused by friction, electricity, lightning, corrosive substances and radiation are classified as burns.

Classification

There are various classifications of burns. Clinically, burns are classified as **superficial** and **deep** burns. Superficial burns involve only epidermis whereas deep burns extend beyond epidermis into dermis, tissues and bone. The following are other commonly used classifications of burns:

1. **Dupuytren's Classification:** It classifies burns into following six categories:
 - (a) **First degree:** It is simple erythema or redness produced on application of heat. Only superficial inflammation is seen. It is painful but disappears in 2 or 3 days. It involves epidermis superficially.

- (b) **Second degree:** In this blisters are formed and redness produced on application of heat. The epidermis is totally affected. It is very painful. They usually heal in 6–7 days.
 - (c) **Third degree:** In third degree burns, the epidermis is totally destroyed and the dermis is involved. These are quite painful as nerve endings are totally exposed.
 - (d) **Fourth degree:** In fourth degree burns, the whole skin is destroyed. The burns are not painful as nerve endings are destroyed. The skin comes out like sloughs after some days.
 - (e) **Fifth degree:** In fifth degree burns, the dermis is destroyed totally. Muscles are also affected. These kinds of burns cause nerve deformity.
 - (f) **Sixth degree:** In this type of burn, charring of the whole limb may be seen. Bones are also charred up.
2. **Heba's Classification:** It classifies burns into three category only:
 - (a) **Epidermal burn:** First degree and second degree mentioned above are grouped as epidermal burns.
 - (b) **Dermo-epidermal burn:** It involves third and fourth degree as mentioned above.

Table 11.1 Differences between scalds and burns

Features	Scalds	Burns
1. Cause	Hot fluids	Dry heat
2. Skin	Sodden and bleached	Dry and shrivelled
3. Vesicles	Present over whole scalded area	Present over burnt area
4. Singeing of hair	Absent	Present
5. Charring	Absent	Present
6. Soot particles in upper respiratory passages	Absent	May be seen
7. Scar	Small scar may be formed	Thick scar seen

(c) *Deep burns*: Fifth and sixth degree burns are called 'deep burns'.

Effects of burns

The following conditions affect the nature of burns:

1. **Intensity of heat**: If the intensity of heat applied is high, more burn results.
2. **Duration**: If exposure is for greater duration, the burns would be more severe.
3. **Extent of area involved**: To estimate the body area of burns, the '**rule of nine**' is applied, which is given in Table 11.2. About 60–80 per cent of superficial burns are fatal while about 40 per cent of deep burns can be fatal, although

Table 11.2 'Rule of nine' to estimate percentage of body area involved in burns

Area	Percentage
1. Head and neck	9
2. Right upper limb	9
3. Left upper limb	9
4. Right lower limb	18
5. Left lower limb	18
6. Anterior trunk	18
7. Posterior trunk	18
8. Genitalia	1
Total	100

cases have been reported where persons have survived even after 80–90 per cent of superficial or 70 per cent deep burns.

4. **Site**: Burns on trunk especially over abdomen are quite severe as compared to limbs. Burns of genital area carry high fatality.
5. **Age**: Children are very often involved in burn but can stand them better. Old people are more prone to death as compared to adults.
6. **Sex**: Men tolerate burns better than Women.

Causes of Death Due to Burns

The causes of death in cases of burns are classified into:

1. Immediate causes
2. Late causes.

Immediate Causes

1. **Shock**: Severe pain and sudden loss of fluid causes hypovolaemic shock leading to death. Usually death occurs within 24 hours. Over 50 per cent of fluid loss is fatal if not corrected immediately. If the burns are about 100 per cent, death may occur within 4–6 hours. Sometimes, death may be reported due to fright or severe pain leading to vasovagal shock (Fig. 11.1).



Fig. 11.1 Body showing 100 per cent burns.

2. **Suffocation:** If the person is caught in smoke and fire; as in a house fire or had tried to commit suicide by pouring kerosene oil over himself, smoke may enter the air passages leading to asphyxia along with burns. In some cases, person dies mainly because of suffocation and shock.
3. **Injuries:** While in process of sustaining burns, the person may sustain some injuries, like hitting an object or injuries from falling walls in cases of a person caught in home fire.

Late Causes of Death

Septicaemia supervenes in 36 hours and signs of infection can be seen in 48 hours. Most of the deaths

occurring after 48 hours are due to infection causing meningitis, peritonitis, pneumonia and other complications.

Fatal Period

Most deaths occurs in severe burns within 24 hours, but deaths in first week are also common. In cases where infection sets in, death may occur even after weeks.

Are Burns Simple or Grievous in Nature?

Burns of first and second degree are simple injury if they are not extensive. Deep burns are grievous as they produce permanent scars. If the person goes into shock after burns, they may be classified as grievous. If burns cause deformity or impairment of movement of joint, they may be classified as grievous. Even extensive first and second degree burns can be classified as grievous if it endangers life or puts the person in severe body pain or if he is unable to carry out daily pursuits of life for more than 20 days.

Post-mortem Findings

These include external and internal features:

1. **External:** The body which has burns should be carefully examined. Clothes should be inspected as they may be found stuck to the body if they are of synthetic nature. The smell of inflammable substances like kerosene, petrol may be there initially.
Pugilistic attitude: When the body is exposed to a very high temperature it causes stiffening of muscles. It is due to coagulation of proteins. Limbs get flexed and fingers hooked like claws. The body assumes an attitude of defence and this fencing posture is called pugilistic attitude. The area involving burns should be carefully noted. Heat rupture of the skin may be seen.

2. **Internal:** Due to heat, skull bones may be fractured and skull may open up. These are characteristics curved fractures in the skull; such fractures are also reported in long bones.

Heat Haematoma

Sometimes, a thin layer of extradural blood may be seen underneath skull which looks like a sponging mass. It is called 'heat haematoma'. Its appearance is that of a honeycomb which makes it different from traumatic haematoma. It is due to intense heat.

The brain along with meninges is congested in case of death due to burns. Soot particles may be seen in upper and lower respiratory passages. Lungs may be congested and oedematous in cases where death has occurred due to the accompanying suffocation. The blood may appear cherry red due to carboxyhaemoglobin.

Sometimes ulceration may be seen in small intestine due to burns which are called 'Curling's ulcer'. The abdominal organs may be found to be congested.

Medico-legal Significance

The burns are of great medico-legal significance. The first and foremost question to be put to a doctor is to ascertain whether burns are ante-mortem or post-mortem.

Ante-mortem Burns vs Post-mortem Burns

The following are the main points to ascertain whether burns are ante-mortem or not (Table 11.3):

1. **Line of Redness:** It is a vital line due to tissue reaction between burnt part and unburned part. It is a permanent line which persists even after death. Some amount of erythema due to distention of capillaries may be seen beyond the line of redness which may disappear after some time. This line of redness cannot be produced in cases of burns after death.
2. **Vesication:** Blisters caused by ante-mortem burns are bigger in size. They have red and inflamed base, contain a lot of serous fluid containing albumin, chlorides and white blood cells; whereas blisters caused by burns

Table 11.3 Differences between ante-mortem and post-mortem burns

Features	Ante-mortem burns	Post-mortem burns
1. Line of redness	Present around burnt area	Absent
2. Vesication	Blisters contain serous fluids with proteins and chlorides The underlying base is red	Blisters contain fluid and air Proteins and chlorides are not seen Base is dry and hard
3. Reparative process	Present	Absent
4. Blood	May be cherry red due to carbon monoxide	Not seen
5. Soot particles in upper respiratory passages	Present	Absent
6. Curling's ulcer	May be seen	Absent
7. Enzyme activity	Present as follows: Immediate – Tissue cathepsin 10 minutes – Serotonin 20 minutes – Histamine 1 hour – Esterases and ATPases 3 hours – Acid phosphatases 4 hours – Alkaline phosphatases	Absent

after death have hard, dry and horny base. These blisters mostly have air and very less quantity of fluid. They may have a trace of albumin and chloride, while there is no white cell.

3. **Reparative Process:** Signs of recovery like formation of granulation tissue, slough and pus formation indicate that the burns were caused during life. Various enzyme studies can also be done which may show enzyme changes, which are absent in post-mortem burns.

The following time-related changes in burns are appreciated:

1. Redness occur immediately after heat application.
2. Blisters form within 1 hour.
3. The crust formation due to dryness of the skin involved starts in 12–24 hours and is completed in 72 hours.
4. Pus formation starts after 36 hours; may be seen in 3 or 4 days.
5. Blisters open up, superficial sloughs may separate out in 5 or 6 days. The deep slough takes longer, i.e. about 15 days.
6. Deformity or complete recovery may be seen in weeks.

Deciding Whether Burns are Suicidal, Homicidal or Accidental

Accidental burns are quite common in women and children. Women may sustain burns while working in kitchen. Children may unknowingly touch hot liquids or solids.

Suicidal burns are rare in men but common in women. Due to the prevalent dowry tradition, there may be harassment of brides in their in laws' house. Many cases have been reported where brides have committed suicide by pouring kerosene oil on themselves and later igniting it. In such cases, severe burns may be seen on head, chest and abdomen. Legs and feet are spared. Presence of a large amount of soot particles in respiratory passage may be seen.

Homicidal burns are also common in women. Where mother-in-law along with other relatives including husband torch the young bride. Many such homicidal burns are reported due to unfulfilled dowry demands.

LIGHTNING

Lightning is a natural phenomenon which may occur between clouds, and clouds and ground. The lightning stroke is a great discharge of current ranging from 10,000 to 2,00,000 amperes occurring in a fraction of a second with a potential of up to 20 million volts. Lightning always follows the path of least resistance. So the branching of current waves can be seen. In lightning, a great amount of heat is also liberated. According to Spencer, following are the four factors in a lightning flash which affect human body and its surroundings:

1. The direct effect of high voltage current
2. Burning by superheated air
3. Effect of expanded and repelled air
4. Sledge-hammer and blow dealt by compressed air pushed before the current.

Effects of Lightning

In fatal cases where lightning strikes a person, he may become unconscious immediately due to sledge hammer blow of compressed air. He may receive burns, and passage of electricity causes immediate failure of nervous system or heart and the person may die immediately. In non-fatal cases, he may have burn injuries and may complain of giddiness and tinnitus.

Medico-legal Significance

Sudden death due to burns may raise suspicion regarding death. But scene of crime visit pays much dividend. Presence of metallic substance getting magnetised and associated history of rain with lightning may solve the riddle.

ELECTRICITY

Deaths due to electricity are quite common in rainy season. The deleterious effects of electricity depend on following factors:

1. **The Nature of Current:** High voltage currents are very dangerous to life. Even low voltage currents of high amperes are dangerous. Alternating currents are more dangerous than direct currents as they produce contraction of muscles by which a person is not able to release the grip on the wire through which the current is flowing. The domestic supply is 210–220 volts alternating current. The current up to 50 volts does not produce deleterious effects. Various cases have been reported where people have survived very high voltage current also.

Judicial electrocution or electric chair:

This form of execution is quite common in Europe, and America and other countries. In this, the person is made to sit on an iron chair with shaven head and is strapped. A high voltage current, about 1800 volts, is passed through his head twice for about 60 seconds. One electrode is kept on his shaven head and one on leg.

2. **Resistance of Body:** The deleterious effects of electricity also depend upon the amount of resistance offered by the body. The human body is a bad conductor of electricity, but if wet, resistance is decreased. If a person is wearing wet clothes or carrying a metallic article touching the ground or where he is not wearing shoes, the body offers less resistance and the person may die easily with less current.
3. **Duration:** Greater the duration of current, more the damage. Even low voltage current for a long duration can cause spasm of muscles and the person may not be able to release himself and die.

Causes of Death

Low voltage currents up to 220 volts cause death by ventricular fibrillation while midvoltage currents up to 1000 volts cause ventricular fibrillation and respiratory centres failure. High voltage current above 1000 volts causes direct respiratory centres failure. Delayed death may occur due to infection, paralysis, etc.

Symptoms

In non-fatal cases, tingling, shocks and severe muscular contraction or spasm are features when a person first touches an electric source. Burns may be found at the point of entrance of electricity or point of exit. These burns are caused as these points offer maximum resistance. Skin may also split due to burns. The pallor on face, dilated pupils and confusion may be seen on the person. Sometimes, cataract may be seen. Headache and loss of memory may be seen in later stages.

Treatment

The person should be removed immediately from the point of electrocution by adopting safety techniques like wearing of gloves, etc. He should be resuscitated immediately as he may be having ventricular fibrillation. Supportive measures like oxygen, etc. should be started. The person should be carefully followed up.

Post-mortem Findings

1. **Joule Burn or Endogenous Burns:** These are characteristic electric marks found on the skin. They are round with a shallow crater surrounded by a slightly raised ridge of skin with a grey ashy base. Clouding of cornea, cataract, retinal haemorrhages, memory loss, convulsions, paralysis, deafness, dumbness, headache, etc. may be seen in many cases.

2. **Filigree Burns:** They are reddish brown arborescent markings (superficial burns) on the skin. These are erythemas which may show the path of passage of electric current in dendritic fashion. These are typical of lightning. They disappear in a few days.

Besides these, singeing of hair, blisters etc. may be seen. The clothes where lightning enters may be burnt. Metallic articles like keys, belt buckle or part of pen may be found magnetised. Rigor mortis may start early and pass off early. The findings mentioned above may be seen. The internal findings are not characteristic. There may be extensive congestion in brain. Internal organs are found to be congested. Rupture of ear drums may be seen and it may resemble the shape of the object through which electricity enters. Microscopically, honeycomb vacuolisation of keratin may be seen. Bullae may be present in and under the epidermis. Epidermal nuclei at the periphery appear hyperchromatic, distorted and fusiform showing a streaming pattern. Joule Burn is typical of electrocution. Metallic particles may be demonstrated in the burn area.

Flash Burns

When a person comes near the high voltage current due to proximity, the current jumps from source to body area and involves large area of skin. These are called 'flash burns'.

The face is usually pale, eyes are congested in most cases. Burns may be seen at the point of entrance and exit. Sometimes, burn at the point of exit may not be there as it is large in area.

Internally most of the organs are found to be congested. Tardieu's spots may be seen in brain and other organs. There are no other significant internal findings.

Medico-legal Significance

Most of the deaths are accidental as the person comes under contact with the electric source. Suicidal death and homicidal deaths by electrocution are also reported.

Visit of the crime scene is very essential to know the mode of death. Examination of electric source by engineers may suggest whether the leaking is tampered with or not.

Iatrogenic Electrocution

The person may also get electrocuted or sustain burn injuries by accidental exposure to X-rays or nuclear radiation in a hospital.

Injuries by Mechanical Violence

DEFINITION OF MECHANICAL INJURY

The mechanical injury is defined as “damage to any part of the body due to application of mechanical force”. This damage may cause loss of tissue. The injury which is associated with loss of tissue is usually referred to as wound. The other common types of injuries are contusions or bruises and abrasions.

Bruises or Contusions

These are caused by application of blunt force like *lathi*, fall from height, road traffic accident, hit with a hard object like stone, hammer (Fig. 12.1), etc. Due to the application of force on the skin, the underlying subcutaneous blood vessels rupture, which causes extravasation of blood in subcutaneous tissues. This is called ‘ecchymosis’. There is no discontinuity in the outer layer of the skin. Bruises are quite painful. The sites of bruises are quite tender and swelling can be seen.

Ecchymosis is observed over the seat of injury in 1-2 hours, although it may appear early where the skin is very thin as of scrotum and eyelids. Sometimes, ecchymosis is seen after 1 or 2 days if the deeper tissues are involved.

Sometimes ecchymosis is seen quite away from the seat of injury, e.g. in scalp. Here they may gravitate into eyelids, commonly called **black eye**. Extent of ecchymosis is dependent on following factors:

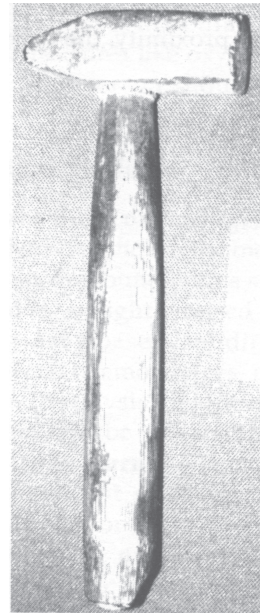


Fig. 12.1 Hammer.

1. Nature and severity of force.
2. Vascularity of area.
3. Amount of subcutaneous fat.
4. Looseness of underlying cellular tissues.
5. Medical condition of the victim.

The more severe the force is, more severe are the contusions. Ecchymosis is severe in soft tissues like eyelids, scrotum and vulva where vascularity is very high. In places where subcutaneous fat is more

like abdomen, ecchymosis is less appreciated. If underlying tissues are loose like those in scalp, ecchymosis may be seen at distal places. In children, bruises are easily produced due to delicate skin. In women and old persons the bruises are easily produceable as compared to young men. In bleeding disorders like purpura, scurvy, haemophilia and pathological condition like leukaemia, there is a tendency to bleed more in bruises.

Severity of Bruises

Bruises are simple injuries in most of the cases. However, if a person receives multiple bruises like in severe beating as in police custody, he may die as a cumulative effect of shock due to pooling of a lot of blood in various areas.

Age of Bruise

The ecchymosis present in the bruise undergoes various changes and this causes colour changes in it. It is due to disintegration of red blood cells, which releases haemoglobin, which, in turn, is subjected to enzyme changes. These changes start at the periphery of the bruise and later move to the centre. The bruises are red at first but in 3 days they appear blue, bluish black or brown. In 5–6 days, they become greenish. They become yellow from 7th day onwards and remain so till 12th–14th day. In about

a fortnight, skin gains its normal appearance (Table 12.1). The colour changes are well appreciated in fair persons as compared to dark persons. In healthy persons, age changes are faster as compared to sick persons. Ecchymosis situated in deeper tissues do not show changes in superficial skin.

Table 12.1 Bruises and time since injury

Time	Changes
Fresh	Bright Red
Up to 3 days	Bluish
4th day	Bluish black/brown
4th–5th day	Greenish
7th–12th day	Yellowish
2 weeks	Normal

Medico-legal Importance of Bruises

The bruises may be accidental, suicidal, or a homicidal in nature. The shape and size of bruise generally correspond to the object. So, the object such as *lathi*, rope, cycle chain, etc. can produce patterned bruises, from which the weapon can be identified.

Bruises may be artificially produced to level false charges against someone (Table 12.2). These false bruises are produced by irritants like juices from marking nut, root of *chitra*, etc. The marks produced by application of such juices looks like contusions but they are dark brown in colour with

Table 12.2 Differences between true and artificial bruise

Features	True bruise	Artificial bruise
1. Cause	Blunt trauma	Usually chemical
2. Site	Any part of the body	Approachable area
3. Colour	Colour changes with time	Usually fresh, dark brown
4. Shape	May be according to the causative weapon	Irregular
5. Margins	Not regular	Vesicles may be seen, margins regular
6. Local inflammation	May not be seen	Local changes seen
7. Itching	No	Usually present
8. Migration	May migrate to other areas e.g. black eye	No migration seen
9. Contents	Blood	Acid serum
10. Chemical Test	Negative	Chemical may be demonstrated

Table 12.3 Characteristic features of ante-mortem and post-mortem bruises

<i>Ante-mortem bruises</i>	<i>Post-mortem bruises</i>
1. Colour changes present	Absent
2. Superficial and deep	Usually superficial only
3. Ecchymosis is more	Very less
4. Signs of inflammation and other vital reactions seen	Absent
5. On microscopic examination, such changes and other changes can be demonstrated	No infiltration of leucocytes

margins covered with tiny vesicles and surrounding skin red and inflamed. If scrapping is taken, the substance can be demonstrated easily. Since these irritants cause a lot of scratching, such marks can be seen. These artificial bruises are always superficial and never deep (Tables 12.3 and 12.4).

Abrasions

Abrasions are injuries where there is discontinuity in the skin due to loss of superficial epithelial layer of the skin. These are produced as a result of blow, fall, slide or being dragged.

The following are the different type of abrasions:

1. **Scratches:** They are produced by a sharp weapon like needle or pin.
2. **Grazes:** They are produced as a result of friction like fall on a rough surface.

3. **Pressure Abrasions:** These are due to sustained pressure on the area just like the ligature mark in hanging, strangulation, etc.
4. **Imprint Abrasions:** Sometimes, the pattern of the object is seen on the skin just like tyre marks or marks of radiator in road traffic accidents.
5. **Other Abrasions:** Sometimes natural abrasions also occur like 'nappy abrasion' which is seen in infants due to excoriation of skin over areas usually covered by nappy like groin and buttocks. It may be confused with mechanical violence.
6. **Contused Abrasions:** If more mechanical violence is used, the abrasion may be contused too, in such cases it may be referred to as contused abrasion or abraded contusion.

Medico-legal Importance

Abrasions may be simple in nature but medico-legally they are very important. The direction of the abrasion can be found out by observing heaped up epidermis at one end. Scratches are observed in strangulation and throttling. Grazes are commonly seen in fall on rough surface or a vehicular accident. The pressure abrasions are seen in asphyxial modes of death like hanging, strangulation, etc. Imprint abrasions are commonly seen in road traffic accidents. Teeth bites are simple abrasions. They are circular in shape represented by 2–4 separate

Table 12.4 Differences between contusion and post-mortem lividity

<i>Features</i>	<i>Contusion</i>	<i>Post-mortem lividity</i>
1. Location	Anywhere on the body	Only on dependent parts
2. Cause	Mechanical forces	Due to gravitation of blood in different parts
3. Surface	Elevation may be seen	No elevation
4. Colour	Different colour changes may be seen with time	Normally purple
5. On cut section	Extravasation of blood seen which cannot be washed off	Blood comes out of cut vessels which can be washed off
6. Signs of repair	Reparative changes seen	No such changes

marks caused by the upper front teeth on one side and same or less number of marks on the opposite side. Traces of saliva can be demonstrated easily if the samples are taken.

Fabricated Abrasions: Sometimes abrasions are fabricated either by the person himself or with the help of another person to implicate someone. The abrasions are usually on approachable parts of the body like face, hands, abdomen, chest, etc.

Age Changes in Abrasions

Within 24 hours, abrasion surface is covered with reddish brown crust commonly called 'scab', due to coagulation of blood. This scab remains for about 10–14 days, after which it falls off without leaving any mark due to the process of healing.

Ante-mortem and Post-mortem Abrasions

Ante-mortem abrasions are seen as bleeding surfaces and show time-related changes due to vital reaction of the body.

Post-mortem abrasions are commonly seen on bony prominences due to dragging of the body. The base appears white, as circulation had stopped earlier. Invariably, there is no bleeding from the post-mortem abrasion and no sign of inflammation or reparative changes are seen on the base. Sometimes, after death, the body is attacked by ants and their marks may simulate ante-mortem bruises. Ant marks are usually seen around mouth, ears, vagina, anus, etc.

WOUNDS

The wound is defined as forcible disruption of continuity by mechanical violence of tissue of the body like skin, cornea, or mucous membrane.

Commonly, wounds are classified as follows:

1. **Incised Wound:** The incised wound is produced by a sharp weapon such as knife, razor, etc. It is always broader than the edge

of the weapon causing it due to restriction of cut tissues. It is spindle-shaped and gaping. The length of the incised wound is greater than its depth. The edges are smooth, clean cut and everted. If an incised wound is caused by a heavy weapon like *gandasa*, the edges of the wound may show contusion. The direction of incised wound should always be noted. The commencement of incised wound is deeper and it gradually becomes shallower and tails off towards the end. The tailing off of an incised wound shows the direction by which the weapon was drawn off. The incised wound bleeds more, as the blood vessels are clean cut and hence bleed more. Small incised wounds on wrist may cause death due to excessive bleeding.

2. **Stab or Punctured Wounds:** Stab wound is an incised wound where depth is more as compared to breadth. It is caused by sharp, pointed and cutting instruments. Stab may have both edges clean cut if the cutting instrument has sharp edges on both sides, or one side blunt and another clean cut if instrument had one sharp and other blunt side. Stab wounds are called penetrating wounds when they pass through tissues, enter a body cavity like thorax or abdomen. A sharp, pointed, cylindrical or conical instrument may produce a wound with circular margins. A blunt pointed instrument may produce circular margins with laceration. The depth of stab wound may be equal to or less than the length of the blade of the instrument causing it. In rare cases depth may be even more than the length of the blade as while forcing the instrument inside, the blow may depress the tissues of the part struck and the blade may reach deeper tissues. This is usually seen in stabs over the abdomen.

Perforating Wounds: When punctured wound perforates the body there may be

entry and exit wound. The wound of entry is usually larger with inverted margins and wound of exit is smaller with everted edges.

3. **Lacerated Wounds:** The lacerated wounds are caused by application of great blunt force on the body, e.g. hit by *lathi* or blow, or in road traffic accidents. These wounds do not generally correspond with the shape or size of the instrument causing them. The margins are irregular, torn, swollen and contused. The underlying tissues show extravasation of blood with muscle tears. Fracture of bones may be seen.

The lacerated wound as a rule do not bleed as heavily as incised wound because in this vessels are crushed and they bleed less. The lacerations are of the following types:

- (a) **Split:** Split laceration occurs when the soft tissues are caught between hard inside surface like bone and the force applied. Scalp lacerations are common.

These lacerations sometimes look like incised wound with naked eye examination. So, they may be called 'incised-looking wound'. But on examination by lens, the margins can be observed. They are irregular, not clean cut as in case of incised wound. The hair follicles would be seen crushed, not cut.

- (b) **Stretch laceration:** They are due to over-stretching of skin by blunt force.
- (c) **Avulsions:** These shearing lacerations are caused due to grinding compression of force such as the wheel of a car passing over limbs, shearing a large area of skin.
- (d) **Tears:** When the body hits a hard object, it can produce tears, e.g. hit by a projected handle of a car in road traffic accidents.
- (e) **Cut laceration:** These are produced by heavy cutting weapon like *gandasa*. Here, careful examination would reveal margins that are irregular and not clean cut. The contusions may be seen around margins with crushed hair follicles.

Fire-arm Injuries

Before knowing about fire-arm injuries, it is better to have an idea about fire-arms and ammunition.

FIRE-ARM

It is a weapon to cause injuries by use of gun powder. Every fire-arm, commonly called 'a gun', has a barrel which is long and hollow cylinder made of steel. The lumen of the barrel is called 'bore'. The rear end of the barrel where cartridge is inserted or loaded is called '*breech end*' while front end is called '*muzzle*'. Missiles are loaded in the chamber situated at breech end. They are driven into the barrel by the detonation of explosive charges which form gases at high temperature and cause great pressure in the barrel, thus forcing the missile out of the barrel through the muzzle end. The projectile has maximum velocity when it leaves muzzle end and it is called '*muzzle velocity*'. By pulling the trigger, a hammer or pin is released which strikes over the percussion cap of the cartridge. It detonates the primar and fires the propellent charge which produces intense gases which carry the missile through the muzzle end.

There are two types of fire-arm weapons commonly seen: smooth bored fire-arms or shotguns and rifled fire-arms.

Smooth Bored Fire-arms or Shotguns

These are heavy weapons carried over the shoulder and they have a barrel which is smooth bored inside. The shotgun may have one barrel or double barrel. These guns are usually used by police to control mob, or they are used in killing birds or small animals.

In shotguns, barrel diameter is called 'gauge', while in rifles or handguns, it is called 'calibre'. A shotgun gauge is indicated by the number of lead balls, each tightly fitting the barrel, and would weigh one pound. Common bores of shotguns are 12 and 16. The shotguns are loaded with cartridge whose construction is given in Figure 13.1.

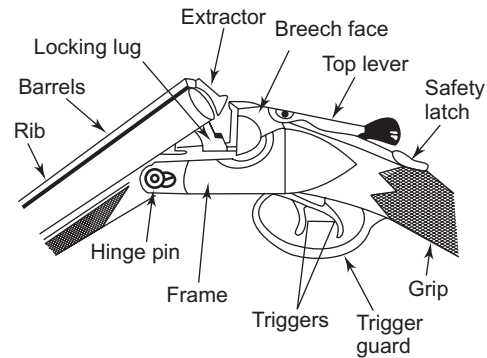


Fig. 13.1 Diagram of a hammerless shotgun.

Shotgun Cartridge

It is usually 5–8 cm in length. It consists of a cardboard or plastic cylinder with a brass cylindrical head, with rimmed base with detonator cap situated in the centre. Below the detonator is the propellant charge. A greased wad or cardboard or felt wad is placed below the propellant charge. The shots are placed below the wad. The shots may be small, rounded lead balls, packed tightly. Below shots a greased wad or cardboard is there.

Choking of Shotgun

In order to control the spreading of shot pattern, narrowing of muzzle end can be done. This process is called 'choking'. It may be of different degree, like full or half choke or quarter choke or improved cylinder. With choking, the spread pattern of shots is reduced and their effectiveness increased.

Range of Fire-arm

It is defined as the distance up to which the momentum of missile drops to the level that human penetration is not possible. It is different from 'useful range', which is defined as the distance up to which the best results are achieved for penetration.

Country Made Fire-arms

Commonly called *kattas*, they are improvised shotguns usually of 12 bores made up of steel tubes. They are all unlicensed. They are widely made in India especially in Uttar Pradesh and Bihar. They are quite unsafe, as while firing they may burst also and kill the person who is firing them. The quality is very poor, but since they are quite cheap and easily available, they are quite frequently used.

Rifled Fire-arms

They are better than shotguns in efficiency. Rifling is a process in which spiral grooves are cut upon

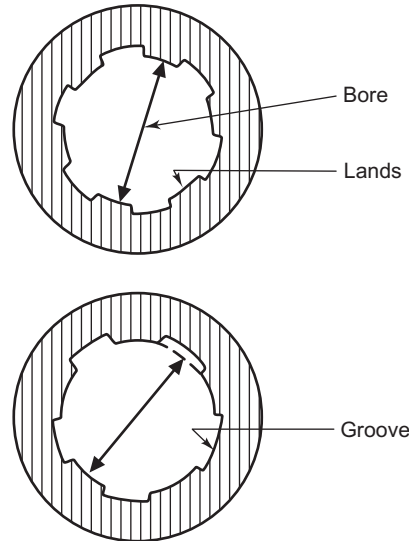


Fig. 13.2 Section of a rifled fire-arm weapon.

the inner surface of the bore to impart rotatory motion to a bullet. It stabilises the bullet and gives greater accuracy and long range for the bullet to hit the target (Fig. 13.2).

The rifled fire-arms are of the following variety:

1. **Rifles:** It is also a shoulder arm gun designed to hit long distance. They can hit at a longer distance than shotguns. The rifles are classified as (a) slide action, (b) bolt action, (c) lever action, and (d) semi-automatic, depending upon the firing mechanism. Short barreled rifles are called 'carbines'.
2. **Hand Guns:** They are fired from hand. Common examples are:
 - (a) **Revolvers:** In this, cartridge or bullet is loaded into a revolving chamber at the breech end of the barrel. It fires one shot at a time. Usually it has 5–9 chambers (Fig. 13.3).
 - (b) **Pistols:** In this case, cartridge is directly loaded into the chamber of the barrel. Sometimes magazine is introduced into it.

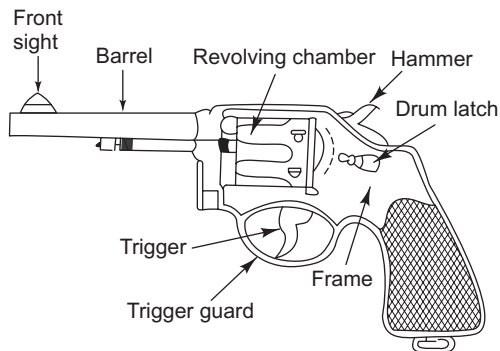


Fig. 13.3 Drawing of a revolver.

Pistols may be semi-automatic or automatic. In automatic pistols, bullets keep on coming out till the trigger is kept pressed.

Cartridge of a Rifled Weapon

It consists of a metal cylinder with a flat base. It may have a projected rim to fit in grooves of

revolvers or pistols. The detonator cap which is an ignitor fits in a circular hole in the centre of cartridges. The distal end of the cylinder has a bullet which is made of lead or lead alloy with an outer hardening of steel or brass. The propellant charge lies between the bullet and the detonator cap (Fig. 13.4).

Propellent Charge

Two types of propellent charges are used:

1. **Black Powder:** It consists of potassium nitrate (75 per cent), charcoal (15 per cent) and sulphur (10 per cent); in this case, charcoal acts as fuel. Potassium nitrate is oxygen supplier while sulphur makes it ignitable. One gram of the powder can produce 3000–4500 cc of gases which consist of carbon dioxide, carbon monoxide, nitrogen, H_2S , hydrogen and methane.

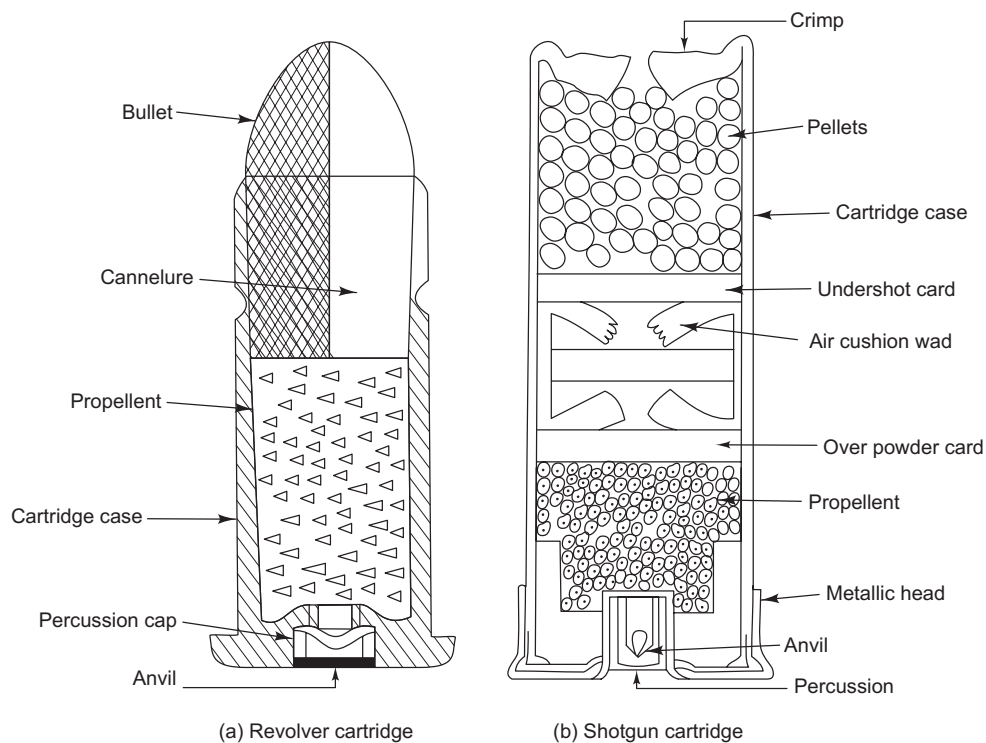


Fig. 13.4 Construction of cartridge.

2. **Smokeless Powder:** One gram of smokeless powder can produce 12000–13000 cc of gas. It may be of the following types:

- (a) **Single base powder:** The propellant charge is made of mainly nitrocellulose and some chemicals to stabilise it.
- (b) **Double base powder:** In this, nitrocellulose and nitroglycerine are the main constituents. It is more powerful than single base powder.
- (c) **Triple base powder:** It contains nitrocellulose, nitroglycerine and nitroguanidine. It is most powerful of the three types of base powders.

Smokeless powder is better than black powder, as it produces more gas and no smoke. In pistols or revolvers mostly smokeless powder is used.

Air Guns: In these, compressed air is used to fire lead shots. They are commonly used for killing birds or in sports like bursting balloons in a fair, etc. These lead shots have limited range. But if fired close to a human body, they can penetrate and if they enter into vital organs like heart, death can occur. It may damage the eyes also.

IDENTIFICATION OF ALLEGED WEAPON OF OFFENCE

Once the bullet fired and lodged into the body is recovered, the weapon from which it was fired can be identified. The bullet recovered from the body or the scene of crime is called 'crime bullet'. It is known that once a bullet is fired from a fire-arm weapon, the marks of rifling and the characteristic individualities appear on the bullet, which are very specific to that weapon.

A test bullet is fired in laboratory conditions from the alleged weapon of offence and markings on the bullet and individual characteristics are compared with the crime bullet. Once they resemble, it can be safely concluded that the alleged

weapon has been used in the crime. The base of the fired cartridge can be used for study of striker indentation and can be compared with alleged weapon.

The crime bullet should be handled carefully. It should not be lifted with forceps, or pincers, as it may produce marks on it. If needed, it should be lifted with covered pincers. The bullet should be preserved in a separate bottle.

FIRE-ARM INJURIES

Before we understand the fire-arm injuries, let us understand how they are caused. When a fire-arm is discharged, following things come out:

1. **Flame and Hot Gases:** When a fire-arm is discharged, immediately a rush of gases at very high temperature leave the muzzle. A great amount of sound is also produced. The gases include nitrogen, carbon dioxide, carbon monoxide, etc. A flash of flame is also observed.
2. **Soot Particles and Powder Tattooing:** Unburnt flakes of propellant also come out with gases and they are deposited on anything which is within their range of travel.
3. **Projectile:** Bullet or lead pellets come out after gases and soot particles. They travel a distance according to their momentum. The pattern of fire-arm injuries depend on the distance between muzzle and victim. Accordingly, the entrance wound of the fire-arm is classified according to that.

Wounds Produced by Rifled Fire-arms

The following are the types of wounds produced by rifled fire-arms depending on the distance between muzzle and victim (Table 13.1).

1. **Contact Wounds:** The following subtypes can be seen:

Table 13.1 Features of entry wound in a case of rifled fire-arm when fired from different distances

1. Contact (in touch with skin)	Largest size, stellate shape, blast effect, edge eversion seen, but blackening, tattooing, singeing, abrasion collar and grease collar missing.
2. Close shot 2.5–7.5 cm from skin	Bullet size entry wound, circular, blast effects absent, no edge eversion. Blackening, tattooing, singeing, abrasion collar and grease collar seen.
3. Near shot 30–60 cm	Entry wound smaller than bullet size, circular in shape. No blast effects seen. Blackening and singeing almost absent. Tattooing, abrasion collar and grease collar seen.
4. Distant shot More than 60 cm	Entry wound smaller and circular. No blast effects seen. No blackening, tattooing, abrasion collar or grease collar seen.

(a) Firm contact with skin with bone

beneath: Such situation is seen when the fire-arm is held in close contact with the head. In this case the gases and projectile enter the skull through scalp but after resistance from the skull bone. Some amount of gases or parts of bullet may be reverted backward causing eversion of margins. In such cases the entry wound is seen as cruciate or star-shaped with everted, rugged margins. Since the discharge of the fire-arm enters skull completely, the underlying bone is fractured in multiple pieces with margins drawn inwards. The effect of flame and soot particles is seen around the entrance wound.

(b) Firm contact with skin with no bone

underneath: In such cases, the discharge enters completely into the soft tissue along with the bullet as there is no firm resistance. In both of the above cases, carbon monoxide present in the discharge enters tissues and combines with haemoglobin to impart pinkish colour to whole of the track. All along the track laceration of muscles, nerves and vessels is seen. Soot particles can also be seen along the track. The bullet may finally hit the bone or enter the

cavity or may come out of body through exit wound. The muzzle imprint can be seen in some cases when the weapon is held against the head forcefully.

- 2. Close-range Wounds:** There is no definite distance of close range wounds but the distance is sufficient to produce flame and soot particles effect. The burning and singeing of hair around the wound is seen, if no clothings are present. Soot particles can be seen around the wound. It is more common with black gun powder than nitrocellulose. Unburnt powder particles of the propellant may produce tattooing of the skin.

The presence of carboxyhaemoglobin can be demonstrated in diminishing concentration all along the track. The abrasion and contusion collar may be seen, but observed less easily due to effect of flame and smoke.

- 3. Short to Medium Range Wounds:** In short range wounds, the effect of flame may not be present but tattooing due to powder deposition may be seen. In medium range wounds, the tattooing is not seen. The entrance wound is clearly observed. It is usually oval, margins are inverted and are smaller than the diameter of the bullet. The direction is inward and backward. The **abrasion collar** around the wound is seen

as the margins are abraded. Sometimes, a **contusion collar** is also seen around the wound. The 'grease or dirt collar' may also be seen around the margins of the wound due to deposition of bullet lubrication or gun oil from the barrel of the gun.

4. **Long or Out of Range Wounds:** Since in these cases, the body is away from the useful range of the fire-arm, the bullet does not have momentum to enter the body (Table 13.2). In such cases, laceration of the skin may be seen.

Exit Wounds

The exit wound is large in size as compared to the entry wound. The margins are everted. The tissue destruction is more and bleeding is more. The differences between entry and exit wound are presented in Table 13.3.

There may be more than one exit wound as the bullet may break down into pieces and each piece may make its own exit wound. Sometimes, bullet may rupture bone into pieces which may also come out making more exit wounds. Sometimes, characteristic features of exit wound may not be seen as in such exit wounds. In a situation where the bullet is coming out through skin, the skin at that point is well supported like presence of belt, clip of bra, etc. which offers resistance. In such situations, the everted margins of exit wounds may not be clearly seen.

Concealed Fire-arm Wounds

The fire-arm wounds may be missed out if the wounds are present in axilla, groin, scrotum, perineal area and entrances of mouth, nostrils, ears, vagina and anus. Presence of hair especially in

Table 13.2 Fire-arm discharge effects in relation to the distance travelled in case of rifled fire-arm

<i>Distance from body</i>	<i>Effects</i>
1. Contact	Blast effect, facial distortion, cherry red discolouration
2. 15 cm	Heat combustion effects
3. 30 cm	Soot particles
4. 60 cm	Fine particles produce blackening
5. 90 cm	Tattooing
6. Effects of bullets	Abrasion collar, grease collar, wounds of entry and exit

Table 13.3 Difference between entry and exit wound of a fire-arm

<i>Features</i>	<i>Entry wound</i>	<i>Exit wound</i>
1. Size	Usually small except in contact wounds	Bigger than entry wound
2. Edges	Inverted	Everted
3. Abrasion collar	Present	Absent
4. Contusion collar	Present	Absent
5. Burning, singeing and blackening	Present	Absent
6. Grease or dirt collar	May be present	Absent
7. Clothes fibres	May be seen	Absent
8. Carbon monoxide	Can be detected in high quantity. Keeps on decreasing as track passes	May be present but very less as compared to entry wound

axilla, pubic area anal area may make wounds difficult to locate.

Multiple Entry and Exit Wounds by One Bullet

Sometimes, one bullet can make multiple entry and exit wounds. For example, if one bullet enters one arm and comes out; then re-enters chest and while coming out may enter another arm.

Wounds Produced by Shotguns

These are described in terms of distance between fire-arm and victim (Tables 13.4 and 13.5) as already done with rifled fire-arm weapons:

1. **Contact Wounds:** The characters already described in rifled fire-arm weapons may be seen. In close contact with skin where
2. **Close Range:** Close range is defined as when distance between muzzle and the body is within a few inches. In these cases,

underlying bone is present, there is a limited area of dissipation of discharge. So, extreme mutilation may be seen due to an explosive effect. Burning, tattooing is less seen at the site as the discharge enters the track and causes blackening and burning along the track.

In situations where the close contact is there but no underlying bony resistance is seen, the blackening and tattooing may be seen around the wound. Most of the discharge passes into the fire-arm track causing soiling, burning of tissues along the track.

Table 13.4 Fire-arm discharge effects in relation to distance travelled in cases of shot gun

<i>Distance</i>	<i>Effects</i>
1. Contact and close shot	Gaseous effect. Blow back effect. Cherry red discolouration around the wound of entry.
2. 15 cm	Gun flame effect. Heat combustion effect on clothes, singeing of hair seen.
3. 30 cm	Blackening due to soot particles
4. 60 cm	Coarse particles causing tattooing.
5. 1.25–2 metres	Cards/wads causing minor injuries.
6. Effects of lead shots	Wound of entry and exit seen in above cases.

Table 13.5 Features of entry wound in relation to the distance of the fire-arm from the body in cases of shotgun

1. Contact shot	Single shot, Largest size, irregular shape, edges scorched or contused. Blackening, tattooing and singeing present.
2. Up to 15 cm	Single shot, smaller size, circular shape, edges well defined and inverted. Blackening, tattooing and singeing present.
3. 90 cm	Single entry wound, size 2.5– 4 cm, irregular lacerated margins, Blackening, tattooing present. Singeing absent.
4. 2 m	Entry wounds may be multiple, spread is 5–7 cm. Central big wound with smaller wounds around. No blackening, tattooing or singeing seen.
5. 4 m	Entry wounds multiple, spread area 10–14 cm, and shape wider. No blackening, tattooing and singeing seen.
6. 20 m	Entry wounds multiple, spread area more than 14 cm. Spread is not measurable. No blackening, tattooing or singeing seen.

burning of skin and singeing of hair is seen. Soot particle deposition is seen. Powder tattooing is also seen. Rest of the features seen are those of a contact wound.

3. **Short Range to Medium Range:** Depending on the distance, the following effects are seen:
 - (a) **Flame/burning/scorching/singeing:** May be seen from 30 cm to one metre.
 - (b) **Smoke/powder marks:** May be seen up to one metre.
 - (c) **Tattooing:** May be seen from 1 to 3 metre.

Spread of Pellets

As the distance increases, the spread of pellets may be seen on the body. It is roughly estimated that spread in feet may correspond to distance in yards between the muzzle and the body.

Depending upon the distance, the pellets may enter the body according to the momentum they have. If the distance increases more than the useful range, pellets may not enter the body.

Shotgun Exit Wounds

Shotgun exit wounds are rare, except in close contact wound. The exit wound may show the same feature as that in the rifled fire-arm weapon except that there may be many exit wounds due to multiple pellets.

UNUSUAL PHENOMENON

The following are the unusual phenomenon commonly seen:

1. **Ricochet Bullet:** A bullet when entered into the body may get deviated due to hitting with hard object like bone and may follow another path. In such circumstances, the exit wound may be found at different places. The dissection of track from the entrance wound may reveal ricocheting of the bullet.
2. **Tandem Bullet:** Word 'tandem' means one after another. It is also called 'piggy' bullet. Sometimes, due to some defect in firing mechanism or obstruction in the tunnel, the bullet does not come out after firing. When the next bullet is fired, both bullets come out one after another. In such cases, two entry wounds or exit wounds may be seen due to the two bullets.
3. **Bullet Embolism:** A bullet may enter blood vessels and thus enter circulation and may lodge at different places causing bullet embolism. Common sites through which a bullet can enter circulation are heart and aorta.
4. **Retained Bullets:** Sometimes, a bullet is retained in the body for a long time. It may be because it was not removed as it was not causing much harm or it was located in an area from where its retrieval could cause more damage to the body. A bullet may remain in the body, especially spine, for years to come without causing any harm. Lead toxicity as a rule is not seen in cases of retained bullets.
5. **Dum-Dum Bullets:** In these bullets tip of the jacket is cut off. As a result, they are expanding in nature. They are very destructive and produce large wounds.
6. **Blank Cartridge:** It is just like an ordinary cartridge except that it has no lead shot or bullet inside. It contains ultrafast burning powder which detonates rather than burns. It is used mainly in riot control or on stage shows. It does not produce injuries but if shot in a very close range, the wad may produce laceration on the body.
7. **Rayalaseema Phenomenon:** In this phenomenon, the person is killed by stab injury and then a bullet is planted inside the stab injury to mislead the investigating officer. Such cases were initially reported from Rayalaseema district of Andhra Pradesh, hence the name. Sometimes unfired or fired bullets are recovered from bodies during post-mortem examinations.

8. **Kennedy Phenomenon:** It is also called 'Magic Bullet phenomenon or Souvenir Bullet'. It is an artefact. In this, sometimes, the doctor who conducts post-mortem may open entry wound of the fire-arm directly and features of the entry wound may be lost. It was done in the case of body of late US President John F. Kennedy who was shot, and the doctor who conducted the post-mortem directly opened the entry wound to remove the bullet.

DETECTION OF GUN POWDER RESIDUE

The following tests are performed to detect gun powder on the hands of a suspect:

1. **Paraffin Test:** It is commonly called 'dermal nitrate test' and is used for detection of gun powder on the hands of the suspect. Hands are coated with a layer of paraffin. After cooling, paraffin casts are removed and then treated with solution of diphenylamine. A positive test consists of blue flecks due to presence of nitrates and nitrites on the hand. However, the test may be false positive if nitrates or nitrites are present on the hands due to any contamination. This test is now not done.
2. **Harrison and Gilroy Test:** It is a colorimetric test to detect presence of barium, antimony and lead on the hands of a suspect who has fired. It is also not done nowadays.
3. **Modern Tests:** The following are generally accepted methods for detecting gun powder on the hands of a suspect who has fired:
 - (a) **Neutron activation analysis:** A sample is prepared either by washing hands with nitric acid or by applying paraffin cast. It is then exposed to radiation of neutrons. Secondary radio-activity is induced due to presence of metallic elements like barium, antimony or lead. This is a very sensitive test.

(b) **FASS (flameless atomic absorption spectrophotometry):** This is a very sensitive test. The test can detect lead, antimony and barium. A sample is obtained as described by hand washing with acid. Usually four swabs are taken, and the fifth one is taken as control. It is worth mentioning that residue is never detected on the firing hand if a rifle or shotgun is used. In these cases, it is detected on the non-firing hand that was used to steady the barrel. Residue is detected more commonly on the back of the hand rather than the palm of the nonfiring hand.

(c) **SEM-DEX (scanning electron microscope-energy dispersive X-ray spectrophotometry):** The residual material is removed from hands and scanned with electron microscope for gun powder residue. X-ray analysis is done to identify metallic ions. This method is very time consuming and costly, but can detect in very low quantities. Demonstration of carbon monoxide can also be done to establish the presence of gun powder in the track.

POST-MORTEM EXAMINATION

The following steps should be taken especially while conducting post-mortem examination in cases of fire-arm injuries:

1. The photograph of the deceased is taken without removing clothes. A front and back view is desirable.
2. Examination of clothes should be done carefully. Loose bullets may be present in clothes. Entry and exit marks on clothes should be noted and described. They should be matched with corresponding marks on the body. Clothes should be removed preferably without cutting.

3. Once the clothes are removed, all the wounds of the body should be photographed again.
4. X-rays of the body in front view and side views should be taken to locate the bullet.
5. Hand washing with nitric acid and finger nail scrapping should be preserved for detection of gun powder residue.
6. All the entry and exit wounds should be described clearly by noting their size, shape, direction and position.
7. The track of all fire-arm injuries should be clearly described in detail.
8. The bullet, if found in body, should be removed gently by non-piercing forceps and sealed separately. Maximum number of pellets that can be collected should be gathered and preserved.

BOMB BLAST INJURIES

Bomb blast injuries are quite common these days. Due to heightened terrorism, now civilians are exposed to bomb blast injuries which soldiers suffered during wartime or crossfire at borders. The blast injuries can affect human body in following ways:

1. **Disruptive Effect:** It affects the person who is quite close to bomb. When bomb explodes, the person may be blown into pieces. If the victim is a bit far away, he may have his limb blown off. These disruptive injuries are quite extensive and victim dies immediately.
2. **Shock Wave:** It is also called 'air blast'. As a result of blast a zone of compressed air is created and it travels further. This wave of compression is followed by a wave of negative pressure. So, the victim bears first impact of compressed air and then negative pressure. The high pressured compressed air can knock down a person easily. This wave causes maximum damage to lungs. It leads to disruptive effect causing rupture of

alveolar septa and cause haemorrhage in alveoli. The air passages are filled up with blood and fluid. The fluid in the alveolar space can cause respiratory failure. These injuries are sometimes referred to as '**blast lung**.'

The shock wave also causes damage to ears. The tympanic membrane is ruptured. The alimentary system also suffers damage due to the pressure of air. The stomach and intestine may rupture. The solid tissues like liver, kidneys, etc. resist the impact of shock wave better than hollow organs like stomach containing air.

3. **Burns:** When a bomb is exploded, the temperature reaches around 2000°C and heated gases are released. They produce burns on victims who are in vicinity of the bomb blast. The exposed areas of the body are severely affected as compared to the covered ones.
4. **Flying Missiles:** These may originate from bomb itself as some bombs contain metal pins, small metal balls or metallic nails which act as missiles and cause injuries to all those present around the site of the bomb blast. Sometimes, as a result of shock wave, small objects may also be thrown as missiles and may cause injuries. The small pins or metal nails used in the bomb may cause multiple abrasions and lacerations due to these flying missiles.
5. **Falling Masonry:** Sometimes a bomb blast in a building may result in its collapse due to shock wave and persons may be caught in the falling debris. People may suffer traumatic asphyxia once caught in the debris. They may sustain head injury or other injuries due to falling stones.
6. **Asphyxia:** In bomb blast, a lot of gases are produced which can cause asphyxia, if the explosion has occurred in a closed area. Common gases are carbon dioxide, carbon monoxide, and hydrogen sulphide.

Post-mortem Examination

The post-mortem examination of bomb blast cases should be carefully done, and following guidelines should be followed:

1. **Identification:** It poses serious problems as bodies are mutilated and disfigured. Sometimes, even pieces of various bodies may be found together. In all such cases, first the reconstruction of bodies should be done, by organs. The number of heads show the number of persons killed. The soft parts should be carefully collected and applied in anatomical positions to know the side to which they belong.
Further identification can be done by:
 - (a) X-ray examination of skull and then subjecting to super-imposition technique.
 - (b) Matching dental record if previous records are available. Compare dental fillings and old fracture in dental record.
 - (c) Preserving tissues, like parts of liver and bone marrow for DNA test to establish identity.
2. **Clothing:** It must be thoroughly inspected and any pieces of explosives may be preserved. The clothes should be preserved and sent for forensic science laboratory.
3. **Injuries:** All injuries should be carefully noted. Any missing parts should be clearly mentioned in post-mortem report.
4. The cause of death should be ascertained taking into consideration all injuries. Usually shock is the cause of death. Death may be instant if the person is blown into pieces.

Medico-legal Aspects of Wounds

MEDICO-LEGAL RESPONSIBILITIES OF A MEDICAL PRACTITIONER

Definitions of a Medico-legal Case

It is a case of injury or ailment where an attending doctor after taking history and conducting clinical examination of the patient, thinks that some kind of investigation by law enforcing agencies is essential so as to fix responsibility regarding the case in accordance with the law of the land.

Registration of a Case as Medico-legal

It is purely the responsibility of the attending doctor to register the case at the earliest. If some delay occurs, the case can be made medico-legal at any time. However, doctor should not act as a detective. The main duty of the doctor is to observe and record things correctly. The request of the patient or relative/friend for not registering the case as medico-legal should not be entertained. The medical officer has to make his own decision.

Can Treatment be Refused to a Medico-legal Case?

Although private practitioners have the choice to select patients, all doctors are ethically bound to render their services in emergency cases without any consideration whether a case is a medico-legal

one or not. However, doctors working in government hospitals, government-aided private hospitals or nursing homes, and charitable clinics have no choice and they cannot refuse any case because it is a medico-legal one.

Formalities to be Completed in a Medico-legal Case

If any case registered as medico-legal in one hospital, dispensary or clinic is referred to another hospital, a fresh injury report need not be prepared even though the case may be labelled as a medico-legal one. The referral slip should be attached to the medico-legal report form. It is important to remember that treatment of every medico-legal case takes precedence over medico-legal formalities if the patient is serious. In all cases, medico-legal report as prescribed by local administration must be filled up correctly.

CASES TO BE LABELED AS MEDICO-LEGAL

The following cases should be labelled as medico-legal:

1. Roadside accidents, factory accidents or any other unnatural mishaps.
2. Suspected or evident homicides or suicides including attempted ones.
3. Suspected or evident poisoning.

4. Burn injuries due to any cause.
5. Injury cases where foul play is suspected, if a doctor thinks that the patient is an accused or a victim in a criminal case.
6. Injury cases where there is a likelihood of death in near future.
7. Suspected or evident sexual offenses.
8. Suspected or evident criminal abortions.
9. Unconsciousness, when the cause of unconsciousness is not clear.
10. Cases brought dead with improper history.
11. Cases referred by courts.

HOW TO COMMUNICATE TO POLICE

Law of the land requires that the doctor should give information to the police at the earliest in cases of medico-legal cases. All the doctors working in the hospitals can give it to the police constable posted in the hospital.

All private practitioners are advised to keep the telephone number of local police station with them. When informing the police on telephone, they should always note down the diary number given by police in their records.

If the local police station does not give a diary number, it is better to telephone police control room at telephone number 100 and ask for diary number. The diary number can save the doctor from harassment/litigation later on, if he is accused that he has not discharged his duty.

Failure to Communicate to Police

A doctor can be charged under Section 201 of the I.P.C. for destruction of evidence if he fails to discharge his duty to inform the police in time.

PRESERVATION OF TRACE EVIDENCES

All clothings worn by the injured patient should be preserved carefully. Similarly, gastric lavage, bullets, pellets, weapons removed from the body of the patient must be preserved carefully and sent

to police under a sealed envelope. All X-rays should be preserved and handed over to the police under proper receipt.

OPINION

It is the most important aspect but is often taken lightly. The doctor has to opine whether the injury is simple or grievous, whether caused by a blunt or sharp weapon or whether it is a case of poisoning. For this, one should have complete knowledge of Section 320 of the I.P.C. which explains what is a 'grievous hurt'.

Grievous Hurt

Section 320 of the I.P.C. defines the following injuries as 'grievous', 'rest' are 'simple':

1. Emasculation.
2. Permanent loss of sight of either eye.
3. Permanent loss of hearing of either ear.
4. Privation of any member or joint.
5. Destruction or permanent impairing of the powers of any member or joint.
6. Permanent disfigurement of head or face.
7. Fracture or dislocation of a bone or tooth.
8. Any hurt which endangers life or which causes the sufferer to be during the space of 20 days in severe bodily pain, or unable to follow this ordinary pursuits.

EXAMINATION OF AN INJURED PERSON

A medical officer is called upon in a government or private hospital to examine an injured person and to treat and opine about the nature and severity of injuries. Every authorised government or private hospital as notified by the government, maintains a register called a 'Medico-legal Register' in their Emergency Department where the detailed examination report of the injured person is written. This register should remain in the custody of the in-charge of the Emergency Department. This

register contains a performa called a 'Medico-legal Report' whose format is approved by the state government.

Always, the medical officer should prepare the report as per the performa. It contains serial number of report, place, date and time of examination, name, age, sex, occupation, and address of the patient. It should be noted whether the patient came himself or was brought by relative or police. A brief summary of how the injured person sustained injuries should be noted. It is followed by detailed examination and description of the injuries. After noting down all injuries, the medical officer should make opinion about the nature and severity of injuries. Finally, he should put his signatures followed by his official seal. While noting down injuries he should carefully note the nature, number, characters of edges, length, breadth, depth and direction of injuries.

Any foreign material, if found in injuries, should be carefully preserved. All the injuries should be measured accurately. While describing position, it is better that its distance from two bony points or anatomical landmarks is mentioned. Description should be so accurate that the medical officer can reconstruct the injuries on the body in court of law if required. Wounds of chest or abdomen should not be probed.

Some Definitions

According to Section 44 of the I.P.C. '**injury**' is defined as "any harm whatever, illegally caused to any person in body, mind, reputation or property."

According to Section 319 of the I.P.C. whoever causes bodily pain, disease or infirmity to any person is said to cause '**hurt**'.

Thus, we can say that in medical practice, we, most of the time deal with hurt rather than injury which has got more than one components.

Legally, '**wound**' is defined as any lesion external or internal, caused by violence with or without breach of continuity of skin. According to Section 351 of the I.P.C. '**assault**' is defined as

'every attack or threat or attempt to apply force on the body of another in a hostile manner'. It does not matter whether the person gets injured or not.

Hurt may be (a) simple or (b) grievous.

1. **Simple Hurt:** All the hurts which do not fall in the category of grievous hurt are simple hurts.
2. **Grievous Hurt:** Section 320 of the I.P.C. defines it as follows:
 - (a) **Emasculation:** It means loss of masculine power. It may be due to cutting of penis or castration early in life, or injury to the spinal cord at the level of 2nd–4th lumbar vertebrae. Castration or loss of testis in later part of life may not cause impotence in an individual as sex in human beings is partially a learned phenomenon.
 - (b) **Permanent privation of sight of either eye:** If there is sight loss in either eye it would amount to grievous hurt. It is not necessary that there should be a complete loss of vision. Even if the vision changes from 6/6 or 6/5 to 6/9, it would be grievous hurt.
 - (c) **Permanent privation of hearing of either ear:** Even if there is a slight loss of hearing in either ear, it would amount to grievous hurt.
 - (d) **Privation of any member or joint:** '**Member**' of the body is defined as the part of the body which has got some distinct function to perform, e.g. mouth, nostrils, ears, eyes, hands, etc. Privation of any member or joint amounts to 'grievous hurt'.
 - (e) **Destruction or permanent impairment of the powers of any member or joint:** If there is some permanent impairment in the powers of any member or joint due to injury it would amount to grievous hurt.

- (f) **Permanent disfiguration of the head or face:** As it is well known that all incised and lacerated wounds heal by secondary intention and thus produce scar, presence of such scar would result in permanent disfiguration of face. If there is a big laceration on head, it can also cause loss of hair on a large area of scalp thus producing permanent disfiguration of head. Injury to nose may result in deviated nasal septum, which may also produce disfiguration on the face of a young woman.
- (g) **Fracture or dislocation of a bone or tooth:** Fracture should involve outer or inner table with or without displacement of any fragment of any bone. If the bone is cut, the cut should go uptill the medullary canal. Only in such cases it would amount to fracture. Dislocation of any bone like clavicle, humerus, etc. would also amount to 'grievous hurt'. In case of tooth, mere loosening should be thoroughly investigated as it may be due to old age or bad oral hygiene or infection. In case of a dislocated tooth, condition of the gums and adjoining teeth should also be taken into account before giving opinion.
- (h) **Any hurt which endangers life or which causes the sufferer to be, during the space of twenty days, in severe bodily pain or unable to follow his ordinary pursuits:** This last clause has got three components:
- A. Any hurt which endangers life: Any injury which can cause sudden death, i.e. within 24 hours of sustaining it, is called injury which endangers life. For example,
- (i) Rapid loss of blood pressure due to haemorrhage.
 - (ii) Perforating injuries of chest, abdomen and skull.
 - (iii) All head injuries showing signs of compression like vomiting, unconsciousness, etc.
 - (iv) Superficial burns more than 80 per cent and deep burns more than 50 per cent.
- B. Any hurt which causes a person to be in severe bodily pain for 20 days would be grievous hurt. For example, a person may be badly beaten and may have contusions all over the body. In this case, all injuries are simple in nature but collectively they may be grievous as person may be in severe bodily pain for 20 days.
- C. Any hurt which causes the person to be hospitalised for more than 20 days and is unable to follow normal pursuits like bathing, eating, sleeping, etc., would amount to grievous hurt. Mere stay of 20 days in the hospital would not constitute grievous hurt. Punishment of imprisonment up to seven years and fine is provided under Section 325 of the I.P.C. for voluntarily causing grievous hurt.

Dangerous Injury

Any injury which can pose imminent danger to life is called 'dangerous injury' and is a part of grievous hurt. For example, injury to large blood vessels, rupture of internal organs, etc.

Injury Sufficient to Cause Death in Ordinary Course of Nature

While admitting a charge under Section 302 of the I.P.C. of murder, it has to be proved that injury was sufficient to cause death in ordinary course of nature. The doctor is called upon to certify this. Any injury, if by virtue of its own direct effect can bring fatal result, is called 'injury sufficient to cause death in ordinary course of nature'. For example,

1. Injury to brain, spinal cord, large blood vessels.
2. Rupture of stomach, intestine, heart, lung, liver, etc.

3. Extensive burns more than 80–90 per cent.
4. Combined effect of many injuries producing shock.

Injuries Necessarily Fatal

The following injuries can be considered as 'necessarily fatal' as recovery from them is impossible:

1. Amputation of head
2. Complete crush injury of head
3. Amputation of both legs at hip level
4. Complete crush injury of chest or abdomen

Sometimes, it is not possible to give immediate opinion regarding the nature of injury. In such cases the patient should be kept under observation. If required, X-rays may be repeated or patient is re-examined after some time. Till the definite opinion is formed, the fact that the patient is under observation should be recorded in the medico-legal report.

KINDS OF WEAPONS

In medico-legal report it is important to mention the kinds of weapons used to inflict the wound. Whether the weapon is blunt or sharp should be decided after careful examination of edges, margins, ends, width and shape of the wound. If an alleged weapon used in inflicting injuries has been brought, it should be carefully examined. Its edges, length, breadth should be correlated with injuries. After examination, it can be opined whether injuries can be caused by such weapon or not. The weapon should be sealed again and then handed over to the police.

AGE OF INJURY

In the medico-legal report, it is essential to mention the age of the injury as it helps in investigation of the crime. The age of bruise can be ascertained by colour changes. The age of abrasion can be found out by the changes in scab formed over abrasion. The age of wound can be ascertained by observing following facts:

The undivided edges of wound would be covered with lymph in about 36 hours. If no infection is present, the edges would join by 3 days and in 7 days wound would heal by primary intention by formation of red, tender and linear scar over the wound. If wound is not aseptic, it heals by formation of granulation tissue by secondary intention. The edges may be bound by blood and lymph and may show traces of pus in 36–48 hours. Such wounds take longer to heal or sometimes do not heal at all.

Once the wound is covered with red scar, healing starts from below. Capillaries are formed in 36 hours and slowly the scar starts showing colour changes. It changes to dense fibrous scar in 3–4 weeks. After 6 months, the scar becomes white, tough and glistening and the underlying tissues are completely healed.

After 6 months, it is difficult to ascertain the age of the scar. The age of the scar can be ascertained by observing reparative process. Up to 3 days, signs of inflammation and haematoma around fracture site can be seen. From 3rd day to 14th day, a soft callus can be seen binding the two ends of the bone. This callus starts ossifying and it takes about 2–8 weeks. The ossification of callus is faster if there is less mobility at fracture site and fracture ends are immobilised after they come close to each other. In 6–8 weeks, the callus is replaced by the bone and fracture ends may be united. In skull fractures, very less callus formation is seen. In comminuted fracture, bone formation does not occur and line of fracture is mostly visible. In dislocation of tooth or removal of tooth by violence, bleeding from socket stops in 24 hours. The cavity of the socket usually fills up in 10 days and alveolar process becomes smooth in 14–21 days.

CAUSES OF DEATH FROM WOUNDS

The following are the causes of death from wounds:

1. Immediate or direct causes
2. Late or indirect causes

Immediate or Direct Causes

These are haemorrhage, injury to vital organ or shock:

1. **Haemorrhage:** It may be external or internal. External haemorrhage normally causes death due to loss of blood, causing fall of blood pressure ending into shock and finally death. External haemorrhage results from cutting of some big vessels like femoral or carotid artery. Sometimes, even a cut on radial arteries can cause death. The loss of about one-third of total blood can lead to death. The sudden loss of blood is more dangerous as compared to the same quantity lost slowly. Children, women and old persons can die from less quantity of blood loss as compared to adult males. Persons who are suffering from bleeding disorders like haemophilia can die because of small injuries.

Internal haemorrhage may occur due to fire-arm or stabbing or hit by blunt weapons. A small haemorrhage in brain or heart can cause death. Commonly, the rupture of internal organs like liver, spleen, kidney, heart or lung can cause internal haemorrhage leading to death. Fracture of long bone like femur or tibia can cause internal haemorrhage sufficient to cause death. Any haemorrhage caused by injury several hours or days back, is called 'secondary haemorrhage'.

2. **Injury to a Vital Organ:** Any severe injury to vital organs like brain, heart or lungs can cause immediate death. Any diseased organ like enlarged spleen can rupture with even minor injuries, leading to death. Crush injuries of vital organs like brain, heart or lung can cause death immediately.
3. **Shock:** The death due to shock may be of following types:
 - (a) **Death due to primary or neurogenic shock:** Sometimes, death may occur due

to sudden fear or fright. It induces vasovagal shock or commonly called 'neurogenic shock'. A blow on the epigastrium or sudden fall in cold water may induce sudden cardiac arrest leading to death.

- (b) **Death due to hypovolaemic shock:** Massive haemorrhage may induce hypovolaemic shock leading to sudden death.
- (c) **Death due to septicaemic shock:** Sometimes, death may be delayed in injuries. As a result of assault on body, infection sets in. Toxins are produced which induce septicaemic shock leading to renal failure and ultimately death. Such death occurs in 3–7 days after the assault.

Indirect or Remote Causes

The following are the common indirect causes of death due to wounds:

1. **Infection:** It is the commonest indirect cause leading to death. Encephalitis, meningitis or pneumonia may cause death rapidly. Infection of the wound may cause toxemia or septicaemia, leading to death by shock. Tetanus may also cause death.
2. **Gangrene** of crushed injuries.
3. **Thrombosis in veins** and consequent embolism can cause death. Pulmonary embolism can also cause sudden death.
4. **Fat Embolism:** It is commonly seen in fracture of long bones and can cause death.
5. **Air Embolism:** Injuries to neck vessels or penetrating injuries to thorax can cause air embolism. Sometimes, air embolism may occur due to tests being conducted to know patency of fallopian tubes by air sufflation techniques. Sometimes, in criminal abortions also, air embolism may occur when uterine veins are suddenly exposed to air.

6. Death due to Supervened Disease

Because of Trauma: Trauma sometimes leads to supervened disease like fracture of long bone may cause osteogenic sarcoma or abdomen injury may lead to hernia which may strangulate and ensures death.

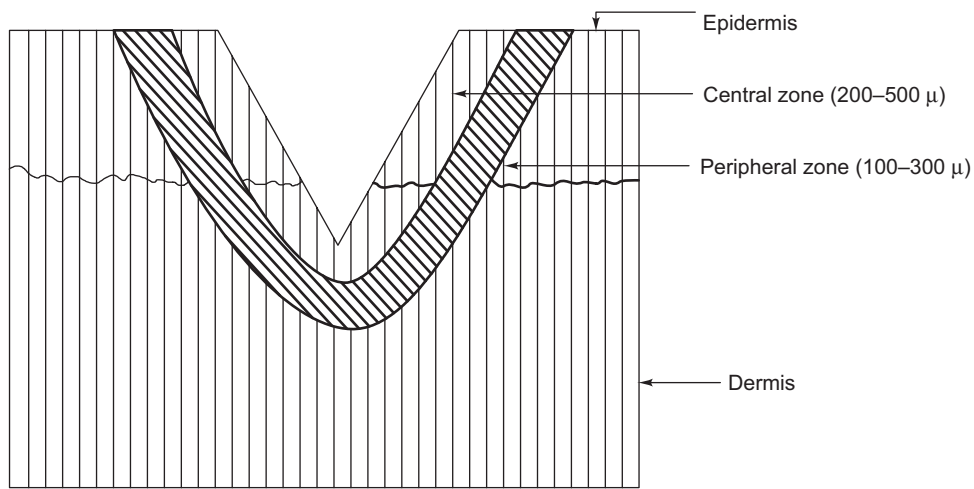
7. Death due to Medical Intervention:

Sometimes, death may occur due to negligence on behalf of patient or doctor.

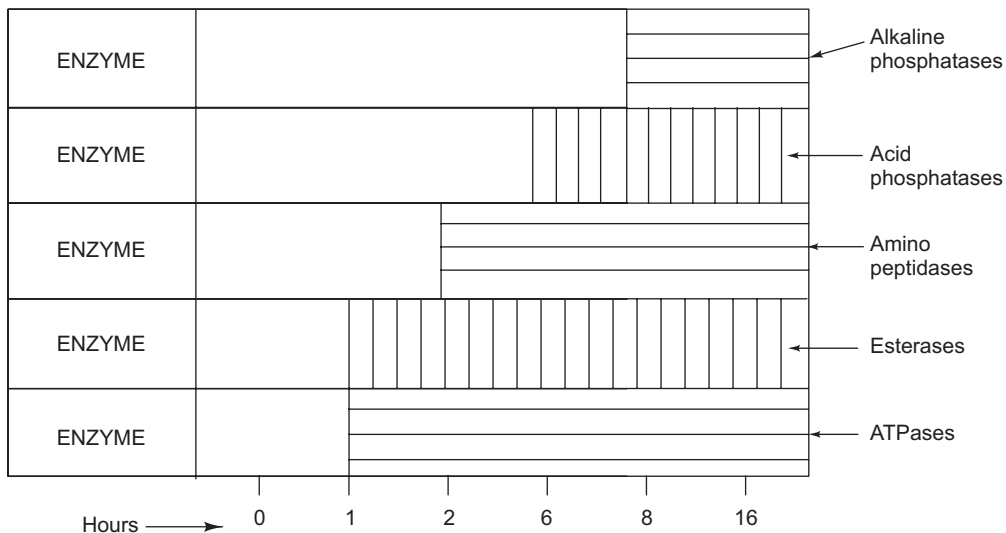
The person may die because of improper medical care or neglect of hospital staff.

ENZYME CHANGES IN WOUNDS AFTER INJURIES

The following are the enzyme changes observed in wounds as a result of vital reaction. In order to under



(a) Zones in ante-mortem wound



(b) Appearances of enzymes

Fig. 14.1 Enzyme changes in wounds.

stand, injury area is divided into central zone (200–500 microns deep) immediately near the injury and peripheral zone (100–300 microns deep) around central zone. As a result of the damage, enzymatic activity is very low in central zone but high in peripheral zone. Within 5–15 minutes of injury, high concentration of histamine and 5-HT can be observed. Within 1 hour, concentration of ATPases and esterases rises. In 2 hours time, amino peptidases activity is seen. Acid phosphatases can be detected around 6 hours; alkaline phosphatases activity is also seen at 6 hours (Fig. 14.1).

Medico-legal Importance

The medio-legal importance of wounds is as follows:

1. **Which Injury has Caused Death:** The doctor is called upon to opine whether the injury is sufficient to cause death in an ordinary course of nature or not. In cases of multiple injuries, the doctor is faced with the situation where he has to specify the injury which has caused death. To sustain a charge of murder under Section 302 of the I.P.C. it needs to establish that the injury was sufficient to cause death in an ordinary course of nature. Sometimes, in cases of multiple injuries, one injury may not be sufficient to cause death but cumulatively multiple injuries may be sufficient to cause death in ordinary course of nature. In all such cases, opinion has to be given after considering all injuries (Table 14.1).
2. **Volitional Acts:** Usually, after sustaining severe injury to vital organs like brain, lung or heart, the person collapses. But in some cases, many volitional acts have been reported by a person who received fatal injuries. Cases have been reported where injured person has come to casualty with

intestines in hand or bullet in heart. Some persons have travelled a lot of distance or performed some heroic acts even when they were fatally injured. In all such cases, opinion should be given after considering all facts.

DIFFERENCES BETWEEN SUICIDAL, ACCIDENTAL AND HOMICIDAL WOUNDS

Whether the wound is suicidal, homicidal or accidental should be decided after consideration of following points:

1. The characters and situations of wounds.
2. The direction, number and extent of wounds.
3. Circumstantial evidence.

The Characters and Situations of Wounds

- (a) **Suicidal wounds:** They are usually situated on front of the body on approachable parts and usually affect vital area. They are usually incised, punctured or fire-arm injuries. Incised or penetrating wounds on the back or on nonaccessible area are usually homicidal.
- (b) **Defence wounds:** They are present on fingers, palms, forearm, back of hands, wrists or between fingers when a person tries to save himself from the assailant with the sharp weapon. These injuries are sustained also when person tries to catch the weapon of the assailant in attempt to save himself. The defence wound denotes attempt to murder. Bruises may be seen in place of cuts if the weapon is blunt.
- (c) **Incised wounds:** They are seen on face, ears, or genitalia show sense of severe jealousy or revenge or sexual jealousy.

Table 14.1 Differences between ante-mortem wounds and post-mortem wounds

<i>Ante-mortem wounds</i>	<i>Post-mortem wounds</i>
1. Very profound haemorrhage in incised wounds, less in lacerated wounds	Very less haemorrhage
2. Mostly arterial bleeding	Mostly venous
3. Spouting seen as a result of bleed from arteries.	No spouting
4. Clotted blood can be seen	No clotting or soft clotting-current jelly or chicken fat
5. Staining of edges deep. Removal with water takes effort	Staining quite less, can be easily removed with water
6. Gaping of wounds seen due to vital reaction	No gaping seen
7. Signs of inflammation seen	No signs of inflammation seen
8. In old wounds, signs of pus or reparative process seen	None present
9. Enzyme reactions can be demonstrated at site	No enzyme activity
10. No signs of putrefaction seen	Signs of putrefaction may be seen

Accidental incised wounds may occur if a person accidentally falls on a sharp object like knife or pin. Favourite sites of suicidal fire-arm wound are temple, in the centre of forehead, roof of mouth, chest or epigastrium.

Usually, fire-arm is held very close or almost in contact with site and show characteristic blackening and tattooing. Weapon may be found held in hand due to cadaveric spasm. In homicidal or accidental fire-arm injury, wound may be present on any area. Lacerated wounds are usually accidental or homicidal. Accidental or lacerated wounds are seen on exposed parts of the body are usually on same side. Lacerated wounds on vertex are usually homicidal.

The Direction, Number and Extent of Wounds

Multiple severe injuries are mostly homicidal except in accidents like motor vehicle, fall or railway accidents. In sexual jealousy assaults,

usually injuries are multiple and severe and may involve genitals (Fig. 14.2).

Self-inflicted Wounds

They are multiple, present on easily approachable parts of the body and are superficial. The purpose of self-inflicted wound is to implicate someone or to attract attention. Usually there are superficial linear cuts or scratches made by a sharp-edged weapon like knife, razor or pin. They are often parallel with straight regular margins.

Hesitatorial or Tentative cuts

Sometimes, more than one cut wound is present on the body. When a person is trying to commit suicide, he starts inflicting wounds but initially he is not able to inflict fatal wound. So, he initially gives one or more cuts which are not fatal, and then he gives the fatal cut. In initial cuts, tailing can be observed. Direction of injury can tell whether a person is right-handed or left-handed. Suicidal injuries over the chest are usually on left side and directed downwards and inwards. Those on upper limbs are usually directed from above downwards. Those on lower limbs are usually



Fig. 14.2 Cut throat with gandasa, see irregular margins.

directed below upwards, those over abdomen are directed below upwards and inwards. If right hand is used, injuries would be seen over left side of body directed from left to right with greater depth on left and tailing off to the right with a downward sloping. In homicidal wounding, plane of disposition is usually horizontal or oblique sloping downwards or backwards. The direction of wound is dependent on relative position of victim and assailant.

Circumstantial Evidence

The examination of the scene of death is very important in solving whether death is suicidal, accidental or homicidal (Table 14.2). If the body has been found within a room locked from inside, it points towards suicide. The presence of suicide

note may reflect his state of mind before death. The condition of clothes may show homicidal pattern if they are found torn or misplaced. Footprints in blood and blood trail may point towards homicidal attack. The signs of struggle in the form of displaced or broken furniture may point towards homicidal attack. The presence of foreign body like cigarette butts, fingerprints of a stranger, hair, etc. should be carefully noted. Due to cadaveric spasm, weapon may be seen firmly grasped in hand in cases of suicide.

Dyadic Deaths: The term 'dyadic death' is used when a person kills someone and then commits suicide. It is mostly seen in family relations like husband-wife, father-wife-children, father and parents or brothers. The reasons may be infidelity in case of spouse, property disputes, unemployment, poverty, or jealousy.

Honour Killings: The victim of these homicides are especially females who defy parents' wish and marry person of their choice out of caste or religion. They are brutally murdered by father or brothers who later surrender to police. Many such cases are reported from the Muslim community from India and the UK. The perpetrators of these homicides think that their daughters or sisters have brought disrepute to the community and family. Such thinking should be discouraged.

SOME COMMON LAW DEFINITIONS

For details see Appendix 2.

Sec. 304 I.P.C

States punishment for culpable homicide not amounting to murder. In this, punishment may extend to 10 years of imprisonment and fine.

Sec. 498 A I.P.C

Deals with harassment for dowry. Husband or relative or the victim can be punished for a term which may extend up to 3 years.

Table 14.2 Differences between suicidal and homicidal cut throat injuries

<i>Features</i>	<i>Homicidal</i>	<i>Suicidal</i>
1. Number	May be multiple of different severity and depth	Single or multiple deep wounds
2. Tentative cuts	Absent	Present
3. Tailing	Either side	Depends on whether the person is right handed or left handed. On right side, if the person is right handed
4. Slope	Away from the floor of the mouth	Toward the floor of the mouth
5. Position	Lower part of neck	Upper part of the neck
6. Direction	Usually horizontal	Usually oblique
7. Direction	Usually upward	Downward
8. Position of carotid arteries	Usually cut as the wound is deep	Usually intact as the wound may not be so deep
9. Bleeding	Mostly arterial	Usually venous

Dowry Death (Section 304 B I.P.C.)

Where the death of a woman is caused by any burns or bodily injury or occurs otherwise than under normal circumstances within seven years of marriage and it is shown that soon before her death she was subjected to cruelty or harassment by her husband or any relative of her husband for, or in

connection with any demand for dowry, such death shall be called a, “dowry death” and such husband or relatives shall be deemed to have caused her death.

All cases of dowry death should be investigated by the magistrate and post-mortem should be conducted by a panel of doctors from different hospitals.

Regional Injuries

HEAD INJURY

Head injury is the leading cause of death in road traffic accidents. It may also be caused in other accidents like fall from height and hit by blunt force as in homicidal attack.

Scalp Injury

Majority of injuries in India are accidental or homicidal. Very rarely, scalp injuries are suicidal in nature, mostly seen in lunatics. Accidental scalp injuries may be seen in vehicular accidents, fall from height or an object falling on the head. Most of the homicidal injuries are caused by hitting with blunt weapon like *lathi* or sharp weapon like sword, *gandasa*, etc. Scalp injuries may be contusion, incised or lacerated wound. In scalp, lacerated wound may look like incised wound. It is essential that edges of wounds be carefully noted as in incised wound the margins would be clear cut and hair bulb clean cut while in lacerated wound, the edges would be irregular and hair bulb crushed. Scalp injuries sometimes go unnoticed being hidden under the hair. Since scalp is a dense tissue, less signs of bleeding, swelling and other signs of inflammation are observed. Scalp injuries may be associated with underlying fractures or head injury.

Contusions on scalp may be seen as haematoma in form of swelling which may be pitting on pressure or may be pulsating. Scalp haematoma may gravitate in front and may present

as eye swelling commonly called '**black eye**'. Scalp injuries are mainly simple injuries unless a large amount of scalp loss is there which may cause disfiguration of head and thus, may amount to grievous hurt. Scalp injuries are better appreciated during post-mortem examination when scalp is reflected and injuries are viewed from inside.

Spectacle haematoma: In this condition, the blood is collected in the soft tissues around the eyes due to fracture of the base of skull.

Skull Fracture

The fracture of skull can sometimes be seen without any injury on scalp. The fracture of skull depends on the type of weapon and force used. The following types of skull fractures are commonly seen:

1. **Depressed Fracture:** It is due to direct impact of weapon on the skull where bone is depressed depending upon the force applied. Since the depression may resemble the weapon, this fracture is also called '**fracture signature**' or '*fracture a la signature*'.
2. **Comminuted Fracture:** It is a case of depressed fracture where bone on fracture site gets broken into multiple pieces. The fragmented parts may get driven into the underlying brain tissue. If there is no displacement of comminuted fragments, the area looks like spider's web or mosaic.

3. **Pond or Indented Fracture:** It may be seen in small infants and children where the skull is elastic. It may be produced by obstetric forceps during childbirth or hit by a blunt object. There may be indentation or simple buckling in of the skull.
4. **Gutter Fracture:** It is due to flanking or grazing by the bullet which produces a furrow in the outer table of the skull.
5. **Linear or Fissured Fractures:** They are linear cracks without any displacement of fragments of skull bones. The line of linear crack is very thin. They are usually caused by a blunt force with broad resisting force like fall on the ground or in road traffic accidents.
6. **Ring Fracture:** This is a type of fissured fracture which encircles the base of the skull around the foramen magnum running 3–5 cm outside foramen magnum at the back and sides of the skull. Such fractures are seen in the following cases:
 - (a) Fall from height where a person falls on feet or buttock and the impact passes upward through the spinal column.
 - (b) Fall from height where head strikes the ground first.
 - (c) Fall of heavy load on head.
 - (d) Violent twisting of head.
7. **Diastatic Fracture:** A fracture is called diastatic when fracture line involves separation of sutures. They are commonly seen in children. These are caused due to broad impact of blunt force like fall from height, road traffic accidents, train accidents, etc.
8. **Basilar Fracture:** Basilar fractures are fractures of base of the skull ranging from linear to a complex one. Basilar fractures are produced by heavy blunt forces like fall, road accidents, etc.
9. **Contre-coup Fractures:** These fractures occur when head is not supported and is

moving. In this, fracture is seen on diagonally opposite side of the skull. It may be depressed, fissured or crushed. Such fractures are common in road traffic accidents.

Meningeal Haemorrhages

The following are common types of haemorrhages:

1. **Extra-dural Haemorrhage:** It is also called ‘epidural haemorrhage’ where bleeding occurs between inner surface of the skull and the dura mater. It is almost always traumatic in origin. Usually, this type of haemorrhage is unilateral. The region most commonly affected is temporoparietal area and the middle meningeal artery or its branch, or accompanying veins are ruptured. Sometimes, posterior meningeal artery may be affected and site of haemorrhage would be parietooccipital or frontotemporal. The clinical presentation of extra-dural haemorrhage sometimes varies due to lucid interval.

Lucid Interval: Sometimes there is delay in onset of bleeding, which may be due to spasm of injured artery. It may range from 30 minutes to 4 hours, to days. So the features of cerebral compression are delayed.

The classic presentation is initially brief loss of consciousness following injury. The victim becomes conscious after concussion and may later collapse after the lucid interval when haemorrhage becomes of enough size to induce symptoms of cerebral compression. Lucid interval has great medico-legal significance as during this time the victim is conscious and well-oriented and is legally fit to discharge any duties. The external haemorrhage cannot be appreciated by plain X-rays. Help of CT scan is required for the diagnosis.

2. **Sub-dural Haemorrhage:** Sub-dural haematoma may be traumatic or non-traumatic in nature. They occur mostly in age group of 50–60 years as compared to extra-dural haemorrhages, which mostly occur in 20–40 years. The following types of sub-dural haematomas are seen:

- (a) Acute sub-dural haematoma
- (b) Chronic sub-dural haematoma

(a) **Acute sub-dural haematoma:** It is almost always traumatic and venous in origin. The various causes are:

- (i) Rupture of communicating veins.
- (ii) Tears in dural venous sinuses.
- (iii) Laceration of dura and tear of middle meningeal artery and bleeding occurs in subdural space.
- (iv) Old adhesions between dura and brain get ruptured.

In acute haematoma, there is rapid accumulation of blood between dura and arachnoid membrane. It is mostly unilateral. It may be associated with brain injury. About 100–150 ml of acute sub-dural haematoma can be fatal.

(b) **Chronic sub-dural haematoma:** These haematomas are usually seen in old persons. Due to old age, the subarachnoid space may increase due to reduction in brain size. This allows more movement of brain within cranial cavity. So, with greater acceleration or deceleration movement of skull there may be bleeding without producing clinical features. But occasionally, the haematoma may be encapsulated by fibrous tissues and may keep on increasing in size due to small recurrent haemorrhages from capillaries. Slowly, the size of sub-dural haematoma may keep on increasing to the extent that it produces clinical cerebral compression after months, or years.

The clinical features of sub-dural haemorrhage may be like extra-dural haemorrhage where lucid interval may be seen. Due to the associated brain injury, the person may pass into shock immediately. Chronic subdural haematoma may raise medico-legal problems. It may be associated with previous history of trauma.

Sub-dural hygromas are usually seen in infants or small children where features of sub-dural haematomas may be seen except, that history of trauma may not have been recorded and bleeding is quite small. It can develop as complication of meningitis, brain trauma or hydrocephalus.

3. **Sub-arachnoid Haemorrhage:** It is the most common intra-cranial bleed following injury to brain. It may be traumatic or nontraumatic in nature. The non-traumatic reasons for this bleed are rupture of aneurysm of artery supplying brain or stroke where intracerebral haemorrhage slips into subarachnoid space. The traumatic subarachnoid haemorrhage may be due to direct trauma to brain, trauma on side of face and neck resulting in vertebral fracture with tearing of enclosed portion of vertebral artery or sudden hyper extension of head causing rupture of arteries at the base of skull.

Usually, sub-arachnoid haemorrhage is seen on parietal and temporal lobes but can be seen anywhere if it is secondary to brain contusion or laceration. Sub-arachnoid haemorrhage has great medico-legal significance as rupture of berry aneurysm may occur due to intense physical activity in cases of assault. Rupture of Berry aneurysm can occur in natural course too, without any history of assault.

CEREBRAL INJURIES

The brain damage may occur due to following reasons:

1. **Direct Cause:** When a foreign body like bullet, or some penetrating weapon enters the skull.

2. **Indirect Cause:** Brain is almost incompressible but it gets damaged as a result of rotational movement in sudden change of velocity, acceleration or deceleration. Violent shaking of small child can causes sub-dural haemorrhage.

According to Gurdijan and Holbourn, cerebral tissue may get damaged because of following reasons:

1. Compression of the various units of brain by their being forced together.
2. Pulling apart of units by tension.
3. Shear strain: It is defined as strain produced to cause adjoining parts of the body to slide relative to each other in a direction parallel to their places of contact.

Coup and Contre Coup Injuries

When an object strikes a stationary head it produces damage on underneath or at least on the same side of impact, it is called 'coup injuries'. But when an object strikes a moving head, there may be a coup injury on the site of impact but the cortical damage is seen on the opposite side of the brain, which is called 'contre coup' injury. Such injuries are quite common in road accidents, fall from height, etc.

Concussion of the Brain (Commotio Cerebri)

It is commonly known as 'stunning'. It is a purely functional disorder, mostly reversible and is minor in nature. Trotter defined it as: "Transient paralytic state due to head injury which is of instantaneous onset, does not show any evidence of structural

cerebral injury and is always followed by amnesia from the actual movement of the accident." Concussion is due to diffuse submicroscopic neuronal damage to reticular system.

Concussion causes immediate unconsciousness or the person may feel giddy. It may last for seconds to a few minutes. Once the person recovers consciousness, he may feel some headache for some time. Memory loss about the incident is quite common.

Post-concussion state is defined by headache, nausea, vomiting, unsteady gait, anxiety and mental fatigability. The complete loss of memory of events before accident or during accident is called 'retrograde amnesia' (Table 15.1). The concussion does not produce any significant post-mortem findings and is not fatal. However, neuronal damage can be appreciated on electron microscope.

Cerebral Contusions

When the integrity of cortical area is disrupted due to linear or laminar stresses on brain tissue, extravasation of blood occurs into the substance of the affected area. The area gets bruised and swollen, and is commonly known as 'cerebral contusion'. The size of cerebral contusion may vary from punctate haemorrhagic spots to a large area.

Cerebral Lacerations

When tearing of brain occurs as a result of injury, it is called cerebral lacerations. These are common in an area which is in contact with bony area, so tips and under surfaces of temporal and frontal lobes are the common places.

Table 15.1 Differences between concussion and drunkenness

Features	Concussion	Drunkenness
1. Smell	None	Alcoholic odour present
2. Skin	Pale, clammy and cold	Flushed
3. Pulse	Slow	Fast and bounding
4. Pupillary reaction to light	Brisk	Sluggish
5. Breathing	Sighs and puffs seen	Slow and irregular
6. Memory	Retrograde amnesia seen	Confused but improves with time
7. Behaviour	Quiet, photophobic	Abusive and uncooperative

Intra-cerebral haemorrhages: In severe head injury intra-cerebral haemorrhages occur immediately after the injury; they are called ‘primary intra-cerebral injury’.

Sometimes, stroke due to uncontrolled hypertension causes intra-cerebral haemorrhage, which may be mistaken as a traumatic one. Absence of either injuries in brain/scalp/skull may rule out any traumatic involvement.

Punch drunkenness or goofy: It refers to chronic changes in the brain in boxers who receive minor head injuries while boxing. The injuries which boxers are likely to receive are sub-dural, sub-arachnoid and intra-cerebral haemorrhages, neuronal injury, focal ischaemic lesions, brain atrophy, etc. The main symptoms are loss of speed and coordination, slurred speech, memory loss, behavioural changes like mood vibrations, etc. Some may have pontine haemorrhage, which is called ‘boxer’s haemorrhage’.

SPINAL INJURIES

Spinal injuries are quite common due to vehicular accidents, falls and blunt trauma.

Concussion of Spine or Railway Spine

This condition is commonly seen in railway or vehicular accidents. There may be paralysis of upper and lower limbs or lower limb alone. Involvement of bladder and rectum is also seen. The person may have headache, giddiness and loss of sexual power. The person recovers in 2 or 3 days and also symptoms disappear. Minor external injury may or may not be there.

This condition resembles concussion of brain and aetiology is, that it is due to momentary collision of spinal cord with walls of the spinal column.

Hangman’s Fracture

In judicial hanging, anterior dislocation of cervical

second vertebra results in instant death due to crushing of spinal cord.

Whiplash Injury

It is commonly seen in roadside vehicular accident where due to sudden stoppage of motor vehicle, there is hyperextension and hyperflexion of cervical spine at the level of fourth to eighth cervical vertebrae. As a result of this the spinal cord gets injured and the person can die at once. Persons who are having cervical spondylosis are vulnerable.

Injury to Thorax and Abdomen

They are commonly seen in adults. Children are less affected. The common chest injuries are:

1. Concussion of chest.
2. Contusions of chest causing pleurisy.
3. Fracture ribs.
4. Flail chest.
5. Injury to lungs as wound, laceration, etc.
6. Injury to heart—stab wound, rupture, cardiac tamponade, etc.
7. Injury to major vessels.
8. Injury to trachea and oesophagus.
9. Incised wounds of abdomen, which may be penetrating to organs like liver, intestine, or kidneys.
10. Blunt injuries to liver, kidneys, intestines, etc.

The major reasons are road traffic accidents, fall from height, crush injuries, stab injuries, etc.

Injuries to Skeletal System

It includes all kinds of fractures.

Medico-legal Importance

The medico-legal importance of injuries to thorax, abdomen and skeletal system has been individually discussed in the concerned chapters.

Injuries to Face and Neck

Injuries to face include abrasions, contusions or burns due to flame or corrosives. Injuries to neck

may be due to stab or blunt trauma. Medico-legal importance of these has been individually discussed in the previous chapter.

Traffic Injuries

Roadside traffic injuries are quite common. The injuries depend on velocity of vehicle, position of victim and the site of impact. If a vehicle is running at a great speed, it would produce severe injuries.

INJURIES TO DRIVER

When frontal impact occurs, which is very common, the face may receive abrasions, contusions and lacerations, and fracture of legs around knee may occur. There may be impact of steering wheel on chest and abdomen, resulting in blunt trauma inside. Fracture of ribs, rupture of liver, and laceration of lungs and heart may be seen. Laceration of aorta may also be seen. Whiplash injury to neck may occur. Injuries to upper limbs may also be seen. Sometimes, impact of collision may be so strong that the driver may be ejected out of the vehicle and may land on the bonnet or on the road.

INJURIES TO NON-DRIVING OCCUPANTS

The front seat occupants may receive same type of injuries as the driver except that there is no hit by the steering wheel in front. The occupants may get ejected out of the vehicle. The rear seat occupants may get severely injured after hitting the front seat or other objects present in the car.

INJURIES TO PEDESTRIANS

The following types of injuries are seen in pedestrians:

1. **Primary Impact Injuries:** These injuries are sustained when any part of vehicle first strikes the victim. Usually, they are seen on legs when bonnet strikes the legs. When the impact is severe, imprint abrasion in the form of tyre mark or bonnet mark may be seen which may help in identification of the vehicle.
2. **Secondary Impact Injuries:** These injuries are sustained as a result of impact between body parts of the victim and the vehicle for the second time as the victim, after being hit by the vehicle is thrown up on the vehicle.
3. **Secondary Injuries:** These injuries are sustained when the victim after being thrown by the vehicle hits the ground. Sometimes, the victim may be hit by another vehicle also.
4. **Crush Injuries:** When a victim is run over by the vehicle, crush injuries are produced. The severity of injuries depends on weight of the vehicle and area of crush injuries.

In a typical case of primary impact injuries, the injuries are seen on legs. The first impact results in fracture of tibia and fibula which may be

compound or comminuted. These are also called 'bumper injuries' as bumper is the first part to hit the body.

INJURIES TO TWO-WHEELER DRIVERS

The injuries to two-wheeler drivers driving motorcycles and scooters are quite common as the vehicle either skids or hits a pedestrian or other

vehicle. In such cases injuries to upper and lower limbs are also very common. Head injuries are also very common; they are more severe if helmet is not worn. Fractura in motorcyclists is often found to be at the base of the skull due to the severe impact by hitting the ground. At post-mortem examination, the base of the skull appears to be divided into two halves, each moving independently like a hinge. Ring fracture may also be seen.

Impotence, Sterility and Artificial Insemination

IMPOTENCE AND STERILITY

Impotence is defined as physical incapability to sustain erection to accomplish sexual intercourse. In males, penile erection may be very feeble or absent. Even if erection is maintained for some time, it may not last till the sexual act is completed. Sterility means inability to produce children. An impotent person may or may not be sterile while a sterile person may or may not be impotent. But in some cases, both conditions are present.

Examination of a Male Person for Impotence

The court may direct a doctor to examine a person and report whether he is impotent or not. Such examinations are usually ordered in rape cases, unnatural sexual offences or divorce cases where impotence is alleged, or in cases of disputed paternity. The doctor should conduct complete physical examination. History of systemic diseases like hypertension, diabetes mellitus should be elicited. In local examination, development of penis, scrotum, pubic hair, etc. should be noted. If possible, cremasteric reflex should be elicited. A brief neurological examination should be done. If nothing wrong is found, the opinion regarding impotence should be given in negative format stating that there is nothing to suggest that this person is not capable of performing sexual intercourse.

Causes of Impotence/Sterility in Males

The following are the causes of impotence/sterility in males:

1. **Age:** Impotence may be seen in very old or young persons. Boys are generally impotent till they achieve puberty, which is around 15–16 years. Some erection may be seen even at the age of 13–14 years. At 15–16 years, the development of genital organs is seen. The pubic hair grow. The penis and scrotum become adult in size. The boys who are at puberty may not be impotent but may be sterile initially as ejaculation of semen takes some more time. Very old persons may become impotent but still they can produce children. But in old age, ability to produce children also decreases.
2. **Congenital Malformations:** Some malformations like hypospadias, epispadias may make a person impotent as penile erection may be painful and acute. Other congenital malformations like absence of penis, scrotum may make a person completely impotent. Impotence may also be seen in cases of male pseudo-hermaphrodites.
3. **Local Trauma or Diseases:** A large inguinal hernia, hydrocele and paraphimosis can cause temporary impotence due to mechanical obstruction. Diseases like

mumps causing orchitis, syphilis, tuberculosis, and cancer may lead to impotence/sterility. Inflammatory diseases of testes, epididymis, and prostate can cause impotence or sterility. Varicocele can cause sterility. Local trauma at genitals can cause physical damage to penis or scrotum and may lead to impotence or sterility or both. Blows on head or spine at level of lumbar 4 or 5 vertebrae can cause neuronal damage resulting in impotence. Exposure to radiations like X-ray or cobalt therapy may cause sterility if testes are exposed to radiation.

4. **Systemic Diseases:** Diseases like uncontrolled diabetes mellitus, hypertension, pulmonary tuberculosis, or any disease causing great disability may result in impotence. Alpha-blocker drugs like atenolol used in anti-hypertensive therapy are known to cause impotence. Prolonged use of alcohol, opium, barbiturates, *Cannabis indica*, tobacco, cocaine and datura may cause impotence.
 5. **Psychological:** Severe anxiety, depression, fear and guilt may cause impotence. Some people are born with low sexual desires. Some persons may have low sexual desire later in life when they channelise more of their energy in career promotion or may become religious. It is sometimes noted that a person may be impotent to one woman but not to others.

While deciding case of divorce, man's sexual impotence is judged only towards wife, not to others. Most of the psychological causes of impotence can be treated with counselling or use of drugs or both.
1. **Age:** Since female is a passive agent in sexual intercourse, she can participate in sexual intercourse even till old age, although young girls before puberty cannot participate as sexual organs are not developed. Puberty in India starts at around 13–14 years of age. With puberty, there is development of genital organs like vagina, clitoris, labia majora and labia minora. Breast development also occurs. Secondary sexual characters develop. Initially, menstrual cycles are anovulatory, so a girl can be sterile initially although she may be potent. Females can bear children till menopause sets in which usually starts at 45th year. After menopause, a female can remain sexually active but she may not be able to bear children, although cases have been reported where women have borne children even beyond 60 years.
 2. **Congenital Malformations:** Such malformation as absence of vagina, adhesions of labia, absence of uterus may make women completely impotent and sterile. Maldevelopment of female genitalia may be seen in intersex cases.
 3. **Local Trauma or Diseases:** Inflammatory diseases of vagina may make sexual intercourse painful for woman and man. Inflammatory diseases of uterus, ovaries or fallopian tubes may make a woman sterile. Neoplastic growths may also make a woman sterile. Local trauma may produce injuries to vagina, labia or uterus and may result in impotence or sterility both.
 4. **Systemic Diseases:** General diseases like hypertension, diabetes mellitus or severe debilitating diseases may make a woman less interested in sex and may make her functionally impotent.
 5. **Psychological:** Extreme hatred, fear, severe anxiety, fear of pregnancy, depression may make a woman impotent and she may refuse to participate in sex. Young virgin girls initially may have vaginismus. In this they

Causes of Impotence/Sterility in the Female

The following are the causes of impotence/sterility in the female:

develop reflex spasm of levator ani, the perineal and adductor muscles of thigh. This results in distressing vaginal contraction rendering penetration impossible. Such cases can be treated by counselling and if needed by introduction of special glass rods to overcome vaginal spasm.

to coincide near-date of ovulation. The semen is usually collected by masturbation after an abstinence of about one week. It is done to increase sperm count. The semen should be used within 2 hours. Nowadays, with cryopreservation, semen can be preserved for a long time and frozen semen can be used when required.

ARTIFICIAL INSEMINATION

Definition

When semen is deposited by artificial methods in vagina, cervical canal or in the uterus to bring pregnancy in an otherwise healthy woman, it is called artificial insemination. When semen of the husband is used it is called 'artificial insemination homologous'. When semen of some other male (donor) is used it is called an 'artificial insemination donor' or 'artificial insemination heterologous'.

Indications for Artificial Insemination Homologous

1. When husband is impotent but not sterile.
2. If there is some problem in vagina of the female where normal sexual intercourse is not possible.

Indications for Artificial Insemination Donor

1. When husband is sterile even if potent.
2. When there is Rh incompatibility between husband and wife.
3. When husband is having mental illness or hereditary diseases.

Procedure

About 1 ml of semen is deposited above internal os by a syringe around 14th day of menstrual cycle

Medico-legal Significance

In India, there are no specific laws regarding artificial insemination, so one should be careful while doing it. Here are some guidelines to be kept in mind:

1. *Consent*: Consent of both spouses must be taken in writing. The whole procedure should be explained in detail.
2. *Confidentiality*: Identity of donor or recipient should not be revealed to each other and donor should not be told about the result.
3. *Selection of donor*: The selection of donor should be done carefully. He must be healthy, below the age of 40 years, should not be suffering from any hereditary or familial disease. He should be screened for HIV, Rh incompatibility and hepatitis B. Complete medical examination of donor should be done. In morphological appearance, it is better that he should be near to the recipient and her husband. He should have children of his own. Consent of his wife must be taken to avoid lawsuit later on. A declaration should be taken from the donor that he will not claim parenthood if the child is born.
4. It is advisable that doctor who is conducting artificial insemination should not be involved in child birth.
5. Semen must be obtained only through masturbation not by sexual intercourse.

Legal Issues in Artificial Insemination

The issues involved are as follows:

1. **Legality:** In cases where semen of the husband is used for artificial insemination, the child is legitimate as child actually belongs to the husband and wife.
2. **Adultery:** Since in cases of artificial insemination donor, there is no actual sexual intercourse as semen is obtained through masturbation and deposited by artificial methods, the act does not amount to adultery.
3. **Nullity of Marriage and Divorce:** Sterility is not a ground for divorce. So, mere artificial insemination is not a ground at all.
4. **Legal Suits:** If a defective child having congenital malformation is born, the doctor who conducted artificial insemination donor, may be sued by the recipient couple. So, proper precautions must be taken.
5. **Future Complications:** Since, the advent of cryopreservation, semen of the husband can be preserved for a very long time. Widow of a person can desire to be pregnant with frozen semen of the husband and may give birth to child. In such cases the child is called posthumous child and a lot of legal questions can be raised regarding legitimacy.

TEST TUBE BABY OR *IN VITRO* FERTILISATION

This is done mainly in cases where woman does not get pregnant by husband due to various reasons which are as follows:

1. Low sperm count
2. Blocked fallopian tube
3. Hostile cervical mucus
4. Unexplained infertility.

In such cases, ova of the woman is fertilised by the sperm of her husband outside the body in

laboratory conditions. The fertilised ovum is then implanted in the uterus of the biological mother. The child is born in natural manner.

Surrogate Mother

In some cases where a woman is not able to conceive due to uterine complications like fibroids, malignancy, septate uterus, etc., the ovum of the woman is taken and is fertilised by the semen of her husband in laboratory, and then it is implanted in some other woman who acts as a mother. She is called a 'surrogate mother'. She is not the biological mother but delivers the child. She returns the child after birth to the biological mother.

Medico-legal Issues in *In Vitro* Fertilisation

The following are the medico-legal issues involved in *in vitro* fertilisation:

1. Sometimes, it is observed that surrogate mother may refuse to hand over the child to the biological mother. Law position in such cases is not clear in India, although in many western countries judgements have been given in favour of the surrogate mother.
2. *Frozen embryos:* Nowadays, in many countries fertilised ova are preserved for a long time by cryopreservation. In such cases, many complications can occur, e.g. if there is divorce between the couple and each seeks custody of frozen embryos. In one case, the couple died in accident leaving behind frozen embryos and one of the friends of the couple agreed to act as surrogate mother and gave birth to the child. Such complications can arise in future.
3. If a defective child is born, the doctor can be sued for wrongful birth.

Recent Concepts

National guidelines for accreditation, supervision and regulation of assisted reproductive technique clinics in India:

In 2005, ICMR/National Academy of Medical Sciences, New Delhi, has formulated national guidelines for accreditation, supervision and regulation of assisted reproductive technique clinics (ART clinics) in India and these have come into force.

The salient features are as follows:

1. Registration of ART clinics have been made mandatory.
2. Minimum physical requirements for such clinics have been prescribed.
3. Essential qualification for ART team has been laid out. It should contain gynaecologist, andrologist and clinical embryologist supported by a counsellor and a programme coordinator/director.
4. ART procedures have been laid out clearly.
5. Artificial insemination with husband's semen is allowed without much formalities.
6. Artificial insemination with donor (AID) is allowed. The common indications for this are as follows:
 - (a) Husband has non-obstructive azoospermia.
 - (b) Husband has hereditary genetic defect.
 - (c) The couple has Rh incompatibility.
 - (d) The woman is iso-immunized, has lost previous pregnancies and intrauterine transfusion is not possible.
 - (e) The husband has severe oligozoospermia and the couple does not want to undergo any of the sophisticated ART technique like ICSI (intracytoplasmic sperm injection).
7. The indications for oocyte donation or embryo donation (ED) have been well defined.
8. Cryopreservation of semen or freezing embryos to be done as per procedure.
9. National Advisory Committee would keep updated new future ART technologies and legalize them.
10. Possible misuse of ART (sale of embryos) and stem cells is banned.
11. Guidelines for patient selection and donor selection have been documented.
12. Code of practice, ethical consideration and legal issues have been described in detail.
13. All information regarding clients and donors must be kept confidential.
14. Requirements for a sperm donor: Following are the requirements for a sperm donor.
 - (a) The individual must be free of HIV and hepatitis B&C infections, hypertension, diabetes, sexually transmitted diseases and identifiable and common genetic disorders like thalassaemia.
 - (b) Donor must not be below 21 years or above 45 years of age.
 - (c) Semen analysis should be done to see if it is normal.
 - (d) The complete medical history and physical characteristics of donor should be noted.
15. Requirement for an oocyte donor — Almost all of the above guidelines should be followed except the fact that the age of donor should not be less than 21 years or more than 45 years.

Medico-legal Considerations

1. ART used for married women with the consent of the husband does not amount to be adultery on part of the wife or the donor. AID without the consent of husband is a ground for divorce.
2. Conception of wife through AIH (artificial insemination homologous) does not necessarily amount to consummation of marriage and decree of divorce can still be granted in favour of the wife on the ground of impotency of husband.
3. The child conceived through AID with proper consents would be assumed to be a

- legitimate child of the couple who seeks ART and would enjoy all privileges of a child born to a couple through sexual intercourse.
4. Children born through the use of donor gametes and their 'adopted' parents shall have the right to available medical or genetic information about the genetic parents that may be relevant to the child's health.
 5. Children born through the use of donor gametes shall not have any right to know the identity of the genetic parents.

Virginity, Pregnancy and Delivery

VIRGINITY

A woman who has not participated in sexual intercourse is called a 'virgin'. The signs of virginity are as follows:

Genitalia

The labia majora in a virgin woman are thick, firm, elastic and round and lie in contact with each other. They cover vulva completely. The labia minora are soft and small. The vagina is narrow and tight. Vaginal walls have rugosity.

Triangular area lying between labia minora with clitoris as apex and the anterior margin of the hymen as base, commonly called vestibule is narrow. The posterior commissure and the fourchette are intact and crescent shaped.

The hymen is a thin layer of mucous membrane situated at the orifice of vagina. It has got a small opening through which menstrual fluid passes.

Types of Hymen

1. **Annular:** When the opening is central, it may be round or elongated in character. The opening is semi-lunar or crescentic with the opening anteriorly.
2. **Fimbriated:** When the free margins of hymen are fimbriated having many notches, it may resemble artificial tears. But these notches do not extend up to vaginal wall and are quite symmetrical. Tears caused by

sexual intercourse are usually situated posteriorly on one side of the median line and extend up to the vaginal wall.

3. **Septate:** When the hymen is divided by a bridge of tissue into two equal or unequal compartments, it is called a septate hymen.
4. **Cribriform:** When there are many minute openings in hymen, it is called cribriform.
5. **Imperforate:** When there is no opening in hymen it is called imperforate hymen. If such is the case, then surgical intervention is needed to make a small hole so that menstrual fluid can pass (Fig. 18.1).

In small children, the hymen is more deep as compared to young girls. So in minor sexual attempt the hymen in small children escapes unhurt. Hymen usually ruptures with first sexual act but it may still be seen in some cases even with repeated sexual intercourse if it is elastic. Besides sexual intercourse, hymen can also accidentally rupture while cycling or by a fall on projected surface. Hymen may also rupture if a girl is involved in masturbation and she inserts some foreign body or when a foreign body like an instrument or two fingers are introduced while conducting medical examination. So, in cases of young virgin girls, vaginal examination is not done routinely. If there is a need, vaginal examination is done by introduction of only one finger. In some diseases like diphtheria hymen may be destroyed due to ulceration.

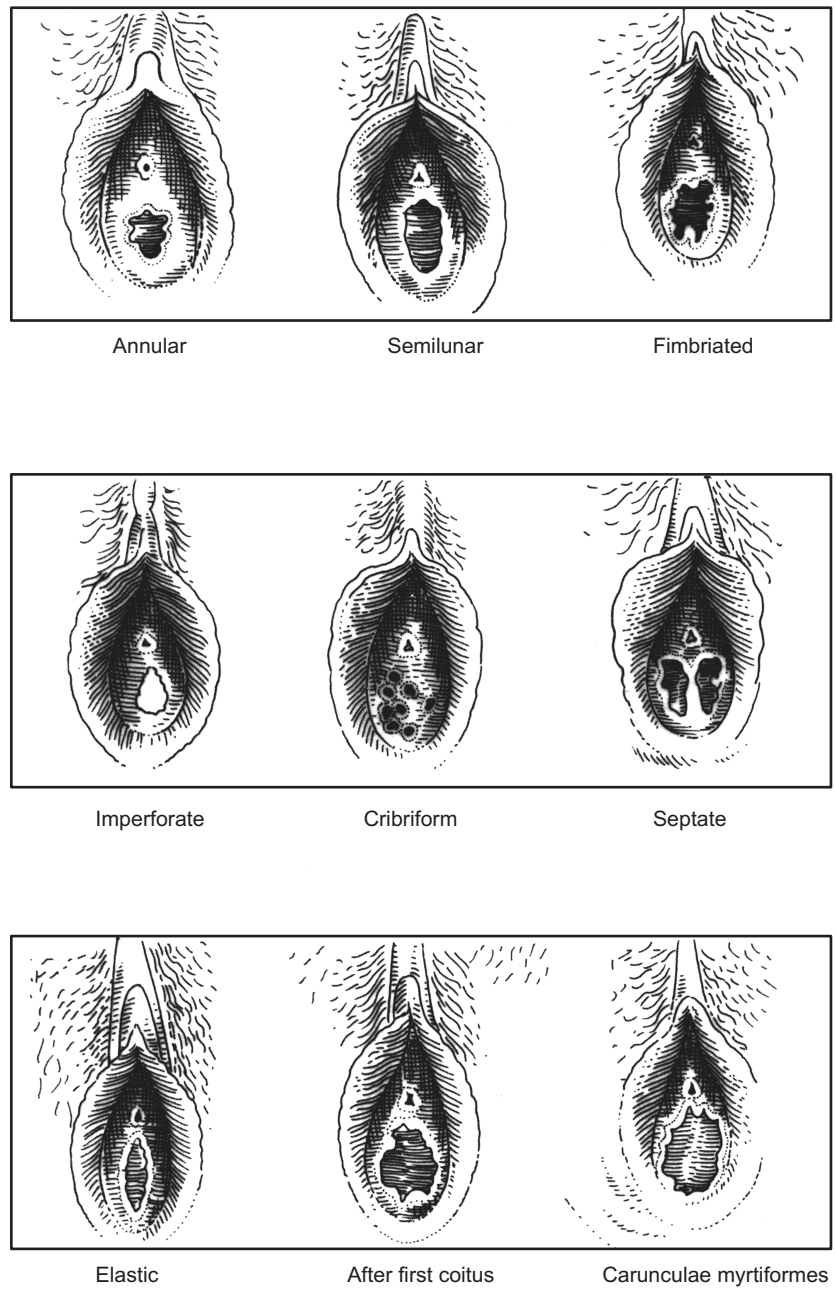


Fig. 18.1 Types of hymen.

Breasts

Breasts in virgin girls are round, firm, hemispherical with a small undeveloped nipples. The areola around the nipple is usually pink. With frequent handling of breasts during sexual intercourse they become loose and saggy.

Medico-legal Aspects of Virginity

The question about virginity of a woman becomes significant in marriage suits like divorce or nullity of marriage. A married woman may approach the court of law stating that her husband is impotent and she is still a virgin. In these cases, the court may ask a doctor to verify that the woman is a virgin or not.

True Virgin

A woman whose hymen is intact and its orifice does not allow penetration of more than one finger can be called a true virgin.

False Virgin

In some cases, hymen is elastic and can easily admit more than one finger. In such cases, hymen remains

intact even with repeated sexual intercourse as it can easily accommodate an object of the size of erect penis. Cases have been reported where hymen was ruptured only during child birth. In such cases while examining, one should look for other signs of virginity to give opinion. Examination of labia majora, labia minora and clitoris should be done carefully to ascertain whether they are consistent with the signs of virginity or not. Only after taking into consideration all this, opinion about virginity should be given (Table 18.1).

PREGNANCY

The signs of pregnancy in a living woman are described as follows:

1. Presumptive signs
2. Probable signs
3. Positive signs

Presumptive Signs

The presence of following signs may raise a presumption that the woman is pregnant:

Table 18.1 Differences between true virgin and false virgin

<i>Characteristics</i>	<i>True virgin</i>	<i>False virgin/deflorated women</i>
1. Breasts: Shape Areolae Nipples	Hemispherical and firm Pink areolae Pink and small	May be pendulous with repeated handling Pigmented and Montgomery tubercles may be there if pregnant Pigmented and enlarged if pregnant
2. Labia majora	Firm and lie in apposition	Separated and flabby
3. Labia minora	Soft and sensitive, pink	Brownish, separate and elongated
4. Clitoris Small	May be enlarged	
5. Fourchette and posterior commissure	Intact	Torn
6. Vestibule	Narrow	Wide
7. Vagina	Narrow, rugae present, walls firm	Enlarged and roomy, rugae may be absent
8. Hymen	Intact. Admits only one finger, insertion painful, membranous	Loose or folded or thick hymen may be seen Easily admits two fingers. Hymen may be fleshy

1. **Cessation of Menstruation:** The commonest reason for cessation of menstruation in a young, adult woman who is not menopausal is pregnancy. But cessation of menses can occur in other conditions like anaemia, emotional stress, endocrine disorders and systemic diseases.
2. **Changes in Breasts:** Initially the breasts become tender and full in size and in 3–4 weeks they start increasing in size. The nipple becomes dark, prominent, harder, firmer and easily erectable. The areolae surrounding the nipple become darker and wider. Small glandular tubercles called **Montgomery's tubercles** appear in this area due to hypertrophy of sebaceous glands. At around 12 weeks of pregnancy, a small colostrum can be squeezed out of breasts on pressure. At around 24 weeks, striae may be seen due to stretching of skin. Sometimes all these changes can be seen in some ovarian diseases and are not diagnostic of pregnancy.
3. **Changes in Vagina:** The mucous membrane of vagina becomes blue from normal pinkish due to venous congestion around 4th week of pregnancy. This is called as **Chadwick's sign** or **Jacquemier's sign**. But this blue discolouration of vaginal wall can be seen in other conditions also, where there is pelvic congestion. Pulsation of vaginal arteries can also be felt.
4. **Pigmentation of Skin:** There is a generalised increased pigmentation of skin especially observed on abdomen, axillae and pubic region. Dark bands called *linea nigra* are observed.
5. **Morning Sickness:** Early morning nausea or vomiting is seen in first three months of pregnancy. However, it is caused in so many other conditions that it is not reliable at all.
6. **Quickening:** When the foetal movements are felt by the mother, she is said to be "quick with the child." It occurs around 20 weeks. Sometimes a woman who is very eager to become pregnant may feel such movements which is called 'pseudocyesis' or 'phantom pregnancy' or 'spurious pregnancy'. Even flatulence may cause such movements.
7. **Sympathetic Changes:** Increased salivation, pica or perverted food taste, irritable temper and easy fatigue are commonly seen.
8. **Frequency of Micturition:** Due to pressure of foetus on urinary bladder there is increased frequency of urination.

Probable Signs

The following are probable signs of pregnancy:

1. **Enlargement of Abdomen:** With the growth of uterus, the abdomen starts enlarging. Uterus remains in the pelvic cavity till 12 weeks. After that there is constant growth. At 24 weeks, it reaches the level of umbilicus. At 36 weeks it reaches the level of xiphisternum or epigastrium. At 40 weeks, as the uterus widens, the fundal height decreases and reaches at the level of 32 weeks uterine size. The enlargement of abdomen can also be seen in cases of obesity, ascites, ovarian or uterine tumours (Fig. 18.2).
2. **Hegar's Sign:** The softening and compressibility of lower segment of uterus can be felt at 3–10 weeks of gestation. It is called 'Hegar's sign'.
3. **Changes in Cervix:** Within first few months of pregnancy, the cervix which is normally as hard as tip of nose becomes as soft as lips. Its softness can be felt by vaginal examination at about 16 weeks. It is also known as 'Goodell's sign'. With advancement of pregnancy, there is shortening in the size of cervix and its orifice becomes circular from transverse and can admit tip of the finger.
4. **Braxton Hicks Sign:** Intermittent uterine contractions, known as Braxton Hick's sign can be observed by placing a hand on

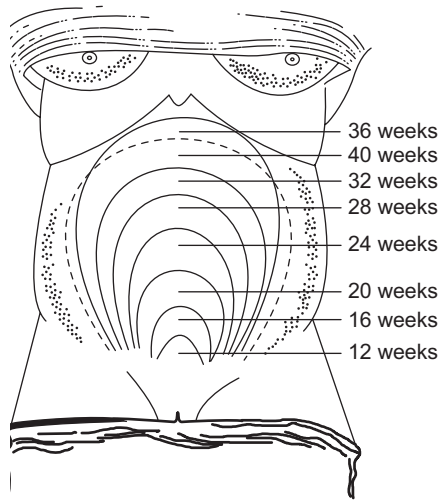


Fig. 18.2 Fundal heights during various durations of pregnancy.

abdomen from 6th week onwards. Each contraction lasts for about 1–5 minutes and relaxation for about 5–20 minutes.

5. **Ballottement:** It can be done internally (through vagina) or externally through abdomen. It is a sensation felt when foetus moves in liquor amnii. It is commonly seen at 16–20 weeks.
6. **Palpation of Foetus:** The external features of foetus can be felt during the second half of pregnancy.
7. **Uterine Souffle:** Soft blowing murmur is heard by auscultation around 16th week due to passage of blood through dilated arteries on either side of the uterus just above the Poupart's ligament.
8. **Endocrine Tests:** The presence of HCG (human chorionic gonadotrophin) in maternal plasma and urine can be detected. A lot of endocrine tests can be done on animals to detect HCG. The following are some of the tests:
 - (a) **Aschheim-Zondek test:** It is done on sexually immature mice. They are inoculated with urine of suspected pregnancy. They are sacrificed after 5 days.

Presence of HCG can be confirmed by detecting presence of corpus luteum and haemorrhage into follicles of enlarged ovaries.

- (b) **Friedman test:** It is done on female rabbit. Morning urine is injected in an ear vein. After 2 days, corpus luteum and corpora haemorrhagia can be detected in ovaries.
- (c) **Hogben or Xenopus test:** It is done on female toad. The morning urine is injected and in 24 hours, extrusion of eggs can be seen through cloaca.
- (d) **Galli Mainini test:** In this, male toad is taken. Morning urine is injected and in 2–5 hours, the extrusion of sperms can be seen. These endocrine tests are not reliable. They are now replaced by immunological tests.
- (e) **Immunological tests:**
 - (i) **Hemagglutination inhibition test:** Based on antigen-antibody reaction, absence of agglutination is seen due to presence of HCG in red blood cells.
 - (ii) **Latex agglutination test:** In this, latex particles are used instead of red blood cells. Inhibition of agglutination shows HCG.
 - (iii) **Radioimmunoassay:** In this, even very small quantity of HCG can be detected. Nowadays, a pregnancy kit is available in the market by which even a layman can do a pregnancy test by simply adding a few drops of early morning urine onto the test plate.

Positive Signs

These are confirmatory signs of pregnancy:

1. **Foetal Heart Sound:** It can be heard around 18–20 weeks of gestation. It is between 120 and 160 per minute.
2. **Foetal Movement:** It can be felt and seen through 16–20 weeks. Foetal parts can also be palpated.

3. **X-ray Examination:** As the centres of ossification start appearing around 16 weeks, X-ray can reveal foetal skeleton. X-ray examination should not be routinely done as it is injurious to the foetus.
4. **Sonography:** It is safest and the best. Here, you can detect foetus as early as 6 weeks. It is nowadays commonly done to detect defects in development of foetus.

Death of Foetus *in Utero*

Initially, non-growth of uterus, loss of foetal movement and heart sound may point towards death in uterus. Later on, radiological examination due to liquefaction of brain, overlapping of skull bones can be seen, it is called **Spalding's sign**. Gas may be demonstrated in heart and great vessels can be seen with collapse of spinal column.

Signs of Pregnancy in the Dead

Pregnancy in a dead woman can be determined in following ways:

1. **Presence of Foetus or Ovum:** The presence of foetus, pregnant ovum or signs of pregnancy like placenta may be seen on post-mortem examination.
2. **Uterine Changes:** The weight of uterus increases up to 1 kg from 30 gm. The length increases from about 4 cm to 30 cm, and width from 4 cm to 23 cm. The marks of attachment of placenta may be seen.
3. **Corpus Luteum:** If a woman becomes pregnant, corpus luteum may start growing and may be observed in ovary easily. The microscopic changes can be observed on histological examination.

Medico-legal Significance of Pregnancy

1. **Civil Cases:** A woman may bring a child in the court of law or may say that she is

pregnant after her husband's death to claim property. A woman may bring lawsuit against a man that she is pregnant and he is refusing to marry her after making promises.

2. **Criminal Cases:** A woman may say that she is raped by a person and is pregnant. The question of pregnancy may arise in cases of infanticide. A woman who is sentenced to death may say that she is quick with child and ask for postponement of death penalty.

Delivery

The question whether a woman has delivered or not arises in cases of abortion, infanticide, concealment of birth, feigned delivery and disputes regarding virginity.

Signs of Recent Delivery in the Living

If a woman has delivered a full term baby, following features are seen:

1. **General Physical State:** Within 72–96 hours of delivery, the woman remains quite weak in disposition. The intermittent contractions of uterus are present and are painful. They are called 'after pains'. Woman generally becomes physically all right by 6–7 days.
2. **Breasts:** They are enlarged, firm and exude colostrum initially, and later milk. The nipples are enlarged and areola dark coloured.
3. **Abdomen:** The tone of muscles is weak. Linea alba may be seen which are initially pink and later becomes white.
4. **Uterus:** Immediately after delivery, uterus decreases in size and may be seen at the umbilicus level. It decreases in size and in 6 weeks it becomes a pelvic organ.
5. **Vagina and Cervix:** The vagina is very tender and may show tears. Labia majora and labia minora are swollen and tender. The cervix is soft and patulous. The internal os

starts closing in 24 hours. Later on external os also closes in 2 weeks.

6. **Lochia:** The discharge from uterus and vagina after delivery is called lochia. Initially it is red in colour till 4–5 days and is called ‘lochia rubra’. Initially it consists of pure blood and clots. Later in 4–5 days, it becomes serous and pale in colour and is called ‘lochia serosa’. After 9–10 days, it becomes white in colour and is called ‘lochia alba’. It disappears in 2 weeks.

Signs of Recent Delivery in Dead

Above signs can be seen in a dead body also. On post-mortem examination, uterus would be found bulky and on opening up may show clot or signs of placenta. Histopathological examination would be of great help. The ovaries and fallopian tubes may be congested. Corpus luteum can be seen in one ovary.

Signs of Remote Delivery in the Living

1. **Abdomen:** The muscles may be relaxed and abdomen may feel flabby. Linea alba, the mark of distention of abdomen during pregnancy may be seen.
2. **Breasts:** They become soft and pendulous. The nipples are enlarged with dark areolae.
3. **Vagina:** The vagina is roomy and its rugae may be absent. The labia are more or less separated from each other. Healed vaginal tears may be seen. The hymen would be absent and cervix os is wider.

Signs of Remote Delivery in the Dead

In multiparous woman, the uterus would be larger, and heavy as compared to nulliparous woman. The changes mentioned above may be seen. If much time has passed, it may not be able to give exact period of delivery.

Sexual Offences

Sexual assault is an act of sexual intimacy done without the consent of the victim, or where consent has been obtained by means of threat, fear or fraud. In our country, sexual assault is a serious offence.

Sexual offences may be described as **natural** sexual offences like rape, or **unnatural** sexual offences like sodomy, buccal coitus, tribadism, bestiality and certain sexual deviations.

NATURAL SEXUAL OFFENCES

Rape

Definition

Rape in India is defined (under Section 375 of the I.P.C.) as an unlawful sexual intercourse by a man,

1. With his own wife under the age of 15 years, or
2. With any other woman under the age of 16 years with or without her consent, or
3. With any other woman above the age of 16 years, against her will, without her consent, or
4. With her consent—when her consent has been obtained by putting her or any person in whom she is interested in fear of death or hurt, or
5. With her consent—when the man knows that he is not her husband and the consent is given because she believes that he is another man to whom she is or believes herself to be lawfully married, or

6. With her consent—when at the time of giving such consent, by reason of unsoundness of mind, intoxication or the administration of any stupefying or unwholesome substance, she is unable to understand the nature and consequence of what she has given consent to.

Explanation

Penetration is sufficient to constitute the sexual intercourse necessary to the offence.

Punishment for Rape

Section 376 of the I.P.C imposes a minimum term of 7 years imprisonment and a maximum of life imprisonment for the offence of rape. However, a judge at his discretion can award lesser sentence.

Custodial Rape

It has been sometimes observed that women are sexually abused in jails, remand homes, hospitals or where the woman is in custody and she is not in a position to render sufficient opposition to the act. In such cases, provisions of custodial rape are attracted under Section 376C, 376D of the I.P.C.

Section 376-D I.P.C

Whoever, being in management of a hospital, or being one of the staff of a hospital takes advantage of his position, and has sexual intercourse with a

woman in that hospital, such sexual intercourse not amounting to the offence of rape, shall be punished with imprisonment for a term extending up to 5 years and shall also be liable to fine.

So, to constitute the offence of rape it is not necessary that there should be complete penetration of penis. Partial penetration within labia majora, or even an attempt at penetration is quite sufficient for the purpose of law. So, it may be possible in a rape case, that there is absence of injuries or seminal stains. Ideally, doctors should refrain from using the word “rape” as it is a legal entity and not a medical condition. The doctor should only mention facts and condition of the victim and state if there is any evidence of sexual activity or not.

In cases where rape cannot be proved, it may be tried under less serious charge of indecent assault on a female committed with intent or knowledge to outrage her modesty. It is punishable under Section 354 of the I.P.C. by a term, which may extend up to 2 years, or a fine, or both. A woman may be accused of an indecent assault on a man but not rape.

Consent

According to the law in India, a woman of 16 years and above is capable of giving consent to the act of sexual intercourse. But the consent must be conscious, free, voluntary and given when she is mentally fit.

In certain sections of custodial rape [under clause (a) to (g) of subsection (2)] of Section 376 of the I.P.C. where sexual intercourse is proved and the question arises whether it was without the consent of the woman alleged to have been raped and she states in her evidence before court that she did not consent (Section 114A, Indian Evidence Act). Thus, the onus of proving consent shifts to the accused from victim in such limited cases.

Prevalence of Rape

According to National Crime Records Bureau Report (1998), there were 15,033 rape cases reported in India. Madhya Pradesh reported the

highest incidence accounting for 22.3 per cent of total cases. Among the cities, Delhi and Mumbai recorded more crimes numbering 365 and 118, respectively. In rates, Mizoram [9.3] led the table followed by Madhya Pradesh [4.3], Dadra and Nager Haveli [3.9] and Delhi [3.4].

Victims of rape were maximum in the age group of 16–30 years accounting for 8,414 out of 15,033 reported cases.

Age

No age is safe for rape. Children are easily abused as they can offer less resistance. Small infants even at the age of 4–6 months have also been abused. Even older women are not safe from rape. For committing rape, the law of India does not presume any limit under which a boy can be considered physically incapable of committing rape. In such cases, the development of child along with development of sexual organs has to be taken into consideration while deciding if he is capable of performing rape or not.

Socio-economic Status

Incidences of rape is reported more from lower socio-economic strata, as they tend to live in unsafe and crowded areas.

Examination of the Victim

The examination of victim should be done carefully as per provisions of law as they are different from one state to another in India. As per the recent judgement of Punjab and Haryana High Court, it is mandatory to get the rape victim examined only by a female doctor. In Delhi, only a gynaecologist does the medical examination of a rape victims. The examination of a rape victim should be under the supervision of a female medical practitioner.

Consent

The consent to examine a rape victim should be taken before commencement of examination. It should be in writing. As per the provisions of law,

police or court has no power to compel a woman to submit private parts for examination to a medical practitioner, male or female.

Examination of the Victim

After taking consent, the medical examination should be started in presence of a female attendant or witness if a male doctor examines the patient. No attempt should be made to undress the woman. She should be politely asked to remove clothes. The exact time of examination, name of the person who brought the victim, a short factual summary of incidence should be recorded in medico-legal report in the register, which has been approved by the state administration.

Two marks of identification of the victim should also be noted. A short description of the place of occurrence of the event, details of the act, relative position of parties, whether ejaculation occurred or not, pain during the act, loss of consciousness during the act or efforts to resist should be recorded. The general behaviour and mental state of the victim should be noted. The detailed examination should begin in the following order:

1. **Clothes:** If clothes are same as ones worn by her at the time of sexual assault, they should be carefully examined for the presence of blood or seminal stain or any other discharge. The clothes especially undergarments should be preserved for examination by Forensic Science Laboratory.
2. **Injuries:** The physical examination of the body especially forearms, wrist, face, breasts, chest, inner aspects of thighs, and back should be done to look for scratches, abrasions or bruises caused as a result of struggle/compression. Teeth marks if any may be observed on breasts, nipples, lips, or cheeks. Swabs from teeth bite should be taken for the presence of saliva.
3. **Genitals:** The examination should be preferably done in lithotomy position. The

pubic hair should be examined first, if they are found to be matted, they should be cut off with a pair of scissors to look for spermatozoa. They should be preserved in a dry bottle for examination at Forensic Science Laboratory. Dried seminal stains on external genitals/thighs can be scrapped carefully, or moistened with normal saline and slides may be made for microscopic examination. If bloodstains are present, they should also be preserved in a similar manner. Bruise or laceration, if any, on external genitalia may be carefully noted. The examination of hymen should be carefully done now. In a case of rape, hymen may have fresh radiate tears (more in posterior half), the edges of which may be red, swollen or painful if the examination of the victim is done within 24 hours. These tears heal within 5 or 6 days, and look like small tags of tissue after 10 days. Frequent sexual intercourse/delivery destroys hymen completely. There may be cases where hymen may be found to be intact and not lacerated. In such cases, the distensibility of hymen can be recorded. The fourchette and posterior commissure are not usually injured in cases of sexual assault. The degree of injury is dependent on the force used. In small children, the hymen usually escapes injury, as it is deep seated but becomes red and inflamed.

The vaginal secretions from the posterior fornix should be taken either by introducing a plain sterile cotton swab or by introducing 1 ml pipette and sucking the contents. The contents should be immediately transferred to a microscopic slide in the form of a thin film, and should be fixed. The slide can be viewed for spermatozoa (Table 19.1). In married women, spermatozoa may be present because of previous sexual intercourse. The spermatozoa can be seen up to 1–7 days in

Table 19.1 Persistence of spermatozoa after sexual intercourse

<i>Sites</i>	<i>Maximum length of time after intercourse</i>
1. Endocervical swabs	144 hours
2. Internal vaginal swabs	120 hours
3. Rectal swabs	65 hours
4. Anal swabs	46 hours
5. Lips of mouth	9 hours
6. Oral swab	6 hours

vagina after the last sexual intercourse. Even if spermatozoa are not present, the estimation of acid phosphatase level can be done in fluid obtained from posterior fornix to detect presence of seminal fluid.

Sexually Transmitted Disease

A woman can get venereal disease as a result of sexual assault, if the person who committed sexual assault was suffering from such a disease. A discharge may be observed in cases of gonorrhoea. A thin film from the discharge may be made, fixed and stained with Gram's stain to look for gonococci under the microscope. The incubation period of gonorrhoea is about 2–8 days, therefore in case of suspicion, another smear may be taken after a few days to confirm. If syphilitic sores are seen or suspected, serum for dark ground examination for *Treponema pallidum* and blood for serological examination should be collected. The incubation period of syphilis varies from 9–90 days, so samples at a later date may be taken for confirmation. The sores on genitalia may be due to chancroid, which can also be confirmed by making smears to demonstrate Ducrey's bacillus, which is a Gram-negative streptobacillus with rounded ends. The other common infections that are transmitted, are chlamydial vaginitis and viral STD like herpes.

The most important sexually transmitted disease is AIDS, which can be transmitted by sexual assault. The chances that a victim may get HIV infection in a single encounter are varied (3–5 per cent).

If it is suspected, relevant tests like ELISA or western blot may be done at repeated intervals to confirm. If sodomy has been attempted or performed, then anal swabs from around the anus and anal canal may be collected and looked for spermatozoa/seminal fluid.

Examination of the Accused

In India, the examination of the accused is done on a written request of the police. The person is brought, under the custody of police, to a medical officer for examination. As per the law, whenever a person is arrested for committing sexual assault, a doctor should medically examine him as early as possible. In most states in India, the examination of the accused is conducted either by medical officers working in emergency services or a dermatologist and venereologist is called upon for examination. In some centres where forensic experts are available, such cases are referred to them. The examination of the accused should be recorded in medico-legal register duly authorised by the state government. The police constable who has brought him should identify the accused. This should be recorded in the report. The consent of the accused is not necessary for examination as per the provisions of the law of India. In fact, a reasonable amount of force can also be applied to collect evidence from this person. The marks of identification should be noted and left thumb impression of the accused may be taken on medico-legal report itself. The medical officer should record preliminary data and then proceed for complete

examination. The examination of clothes should be done to detect semen/bloodstain or tears. Undergarments should be especially looked for stains and should be preserved for examination by Forensic Science Laboratory. A complete physical examination involving all systems like cardiovascular, alimentary, respiratory and nervous should follow.

The complete body, especially inner aspects of thighs should be examined for mud, blood or seminal stains. The genitalia should be examined. Pubic hair, if matted, should be cut and preserved. The penis should be examined for injury or some stain, circumcision, presence of smegma or discharge. The cremasteric reflex may be elicited to rule out neuronal loss. If it is suspected that a person is suffering from STD, relevant evidence may be collected.

After the examination is over, the doctor has to give opinion on two accounts:

1. Whether the person is capable of performing sexual intercourse or not?
2. Whether there is an evidence of recent sexual intercourse?

The capability to perform sexual intercourse depends on erection of the penis. It is naturally assumed that all normal males who have well developed sexual organs are capable of erection, thus can perform sexual intercourse. So, the opinion about capability to perform sexual intercourse is given in a double negative form like “there is nothing to suggest that this person is not capable of performing sexual intercourse.”

If it is suspected that the person may have some erectile dysfunction, he should be examined for chronic diseases like diabetes, hypertension, chronic alcoholism, neuropathies, or some psychic reasons. The opinion about recent sexual activity can be given if some stain/injury/redness is seen on the penis/scrotum. Previously, it was thought that absence of smegma could indicate recent sexual activity. Now it is not relied upon, as smegma collection depends on personal hygiene and circumcision.

Samples may be collected of vaginal epithelial cells, which adhere to penis during sexual intercourse, by taking a wet swab around penis and making microscopic slides. These vaginal cells are rich in glycogen and stain readily with iodine and can easily be inspected microscopically.

Previously, it was common to preserve semen in accused for which accused used to be asked to provide sample by masturbation. In non-cooperative accused, it was obtained by doing prostatic massage. Now, this is not done. Sample of blood obtained from finger is preserved on a gauze piece, and is dried and then sealed for examination by Forensic Science Laboratory.

Incest

Incest is defined as sexual intercourse between man and woman who are related by blood or by marriage, i.e. within forbidden degrees of relationship like a daughter, granddaughter, sister, stepsister, niece, aunt or mother. In India, incest *per se* is not a crime unless it attracts provisions of rape. However, in many western countries, incest is recorded as a crime and is punishable.

UNNATURAL SEXUAL OFFENCES

Section 377 of the I.P.C. defines sexual offences relating to “carnal intercourse against the order of nature with any man, woman or animal”. Penetration is sufficient to prove the offence. The unnatural sexual offences are punishable with imprisonment for life or with a term of 10 years and also with fine.

Incidence

In India, unnatural sexual offences as mentioned above are quite less in percentage as compared to western countries. The sodomy is frequent with small children working in tea stalls, motor workshops or offices. The sodomy has also been reported in prisoners or in armed forces, especially those posted in the hilly areas or remote areas.

Classification

These offences are classified as:

1. Sodomy: It is also called 'buggery' and is defined as anal intercourse between man and man or between man and woman. If the passive agent is a young child, it is called 'pedestry'. Recent Supreme Court Judgement has decriminalised the offence of sodomy between two consenting adults. Now, sodomy with consent is not an offence in India.

2. Buccal coitus: It is also called 'sin of Gomorrah' when genitalia are stimulated by mouth or penis is introduced in mouth. Sudden deaths have been reported by impaction of penis into lower part of pharynx or aspiration of semen ejaculate.

3. Bestiality: It is defined as when a lower animal is used for sexual gratification. The common animals, which are subjected to this cruelty are dogs, sheep, cats or sometimes cows or buffaloes. Usually, penis is inserted into vagina or rectum of the animal. Cases have been reported when animals, especially dogs have been stimulated to perform sexual intercourse by inserting their penises into vagina of woman. Since these offences are punishable under law, they may be brought for medical examination to the doctor.

Examination of the Victim of the Passive Agent

Usually, the police brings a victim or a passive agent of sodomy for medical examination to the doctor. The consent of the victim or passive agent must be taken. The examination should preferably be done in knee elbow position. Abrasion, contusion or laceration may be seen around anal sphincter and person may complain of severe pain. These injuries are more important if the victim is a small boy or girl as compared to the accused person and a great force has been used to penetrate. Blood or semen stains may be present around anus and they should

be lifted as described earlier. Swabs from inside and around anus must be taken and examined microscopically. In a person who is habituated to sodomy, following features may be present:

1. Shaved of anal hair.
2. A funnel-shaped depression of buttocks toward anus.
3. Complete relaxation of anal sphincter when lateral traction is applied on both buttocks.
4. Anus dilated and patulous, with disappearance of radial folds. Prolapse of rectal mucosa may be seen.
5. Old lacerations around anus.
6. Complete absence of injuries.
7. Presence of STD in form of discharge, chancre or wart.

Examination of the Accused

The examination of an accused is quite helpful if done within hours of the act, as the signs start decreasing with time. The examination of the accused must be done on written request of the police. Consent is not required. The marks of identification must be noted. The complete physical examination, as in the case of accused of rape, must be done. There may be abrasion on the prepuce, glans penis or frenulum. Stains of faecal material may be seen on penis. The swabs must be taken from penis and the area around to look for faecal material. The blood/semen stains may also be present and should be lifted as described earlier. There may be marks of struggle on the body. If the person is suspected/suffering from STD, the victim should also be examined for the same.

Bestiality is observed in villages in young shepherds who take animals for grazing and remain with them for almost the whole day.

LESBIANISM

This refers to female homosexuality which is practised between two females and mostly consists in friction of external genital organs by mutual body

contact for sexual gratification. In some cases, the clitoris of the woman may be found to be enlarged. In some cases, artificial object may be used for stimulation. Lesbianism is not punishable as it is not a crime under Section 377 of the I.P.C. It is usually found in females who are living together, e.g. in hostels or asylums.

SEXUAL DEVIATIONS

The common sexual deviations are described as follows:

1. **Sadism:** This is a sexual perversion where infliction of pain, torture and humiliation to partner act as sexual stimulants. It may be seen in both the sexes but is common in males. Male may inflict injuries by beating with hands or sticks, or sometimes sexual organs may be targeted, foreign bodies may be inserted in vagina and breast may be contused or sometimes, the sadist may get so excited, that he may murder the victim (lust murder) or he may eat her body (necrophagia) after raping her corpse (necrophilia).
2. **Masochism:** It is just opposite of sadism where gratification is obtained by getting beaten, tormented or humiliated by the sexual partner. It is common in males but occurs in females also. The females may invite males to inflict pain on her or abuse her.
3. **Fetishism:** This perversion is seen in males only. In this, male gets sexual gratification just by seeing some part of the woman or her article like undergarment, shoes, clothes, etc.
4. **Transvestism:** It is the desire to wear the clothes of the opposite sex. It is quite common in homosexuals. Some transvestites may seek medical treatment to change their gender.
5. **Exhibitionism:** It is a deviation in which exhibitionist gets pleasure by showing his genitals to women, girls, or small children. He may also make some lewd gesture. It is a punishable offence under Section 294 of the I.P.C.
6. **Scoptophilia:** It is deriving sexual pleasure in anticipation of exposure of one's genitalia or observing genitalia of another with orgasm brought by masturbation during or after the event. Some people get excitement by listening to or making obscene phone calls.
7. **Voyeurism (Peeping tom):** It refers to repetitive seeking for situations where person of the opposite sex is undressing, taking bath or having sex. It is also like watching porn movies. The males who are involved in this are often called peeping toms.
8. **Paedophilia:** It is defined as preferential sexual activity with children. It may be limited to watching them nude or showing genitalia to them or touching young ones to their nubile sex organs. If sexual intercourse is done, it comes into the category of rape or sodomy as the case may be. Many celebrities have, in the recent past, been accused of paedophilia. Some perverts enjoy watching porn movies involving children.
9. **Necrophilia:** It is a perversion when a person attains sexual gratification by watching dead nude body or doing sex with a dead body. Some people are so pervert that they eat some parts of the dead body too. It is called as 'necrophagia'. This is a punishable offence where term may extend up to one year or a fine is charged or both are implemented.
10. **Troilism:** In this, a person gets sexual gratification by watching his own wife performing sexual intercourse with some other man.
11. **Nymphomania:** It is often described as excessive sexual desire in woman where she enjoys having multiple sex partners or desires excessive sexual activity.

12. **Satyriasis:** It is an excessive sexual desire in males who may seek multiple sex partners or need sex more frequently as compared to normal men. Such men often visit brothels to seek sexual gratification, or have multiple sex partners.
13. **Frotteurism:** It is a sexual deviation in which the person gets pleasure by rubbing with bodies of opposite sex like in crowded bus, train or fairs. They may try to rub their genitalia against bodies of opposite sex in such situations. It is punishable in India.
14. **Undinism:** This is a sexual deviation where the person gets pleasure by watching a person of opposite sex doing urination or defecation in public or asking them to urinate on him or her.

SEXUAL HARASSMENT

Many cases are reported every day of sexual harassment of women by the superiors at their workplace; such cases created a strong public awareness to fight this evil. Government of India has taken a serious view to fight this evil. A specific provision has been made in CCS (Conduct Rules), 1964, prohibiting sexual harassment of women by government servants. This provision is Rule 3- C of CCS (Conduct Rules), 1964. The government can initiate severe penal action against its employees. In private institutions also, rules have been made to deal with this menace. The rules are based on the guidelines and norms laid down by the Supreme Court in *Vishaka and others versus State of Rajasthan and others* [JT 1997 (7) SC 384].

It is necessary and expedient for employers in workplaces as well as other responsible persons or institutions to observe certain guidelines to ensure the prevention of sexual harassment of women.

Definition

For this purpose, sexual harassment includes such unwelcome sexually determined behaviour (whether directly or by implication) as:

1. Physical contact and advances.
2. A demand or request for sexual favours.
3. Sexually coloured remarks.
4. Showing pornography.
5. Any other unwelcome physical, verbal or non-verbal conduct of sexual nature. Where any of these acts is committed in circumstances whereunder the victim of such conduct has a reasonable apprehension that in relation to the victim's employment or work whether she is drawing salary, or honorarium or voluntary, whether in government, public or private enterprise, such conduct can be humiliating and may constitute a health and safety problem. It is discriminatory, for instance, when the woman has reasonable grounds to believe that her objection would disadvantage her in connection with her employment or work including recruitment or promotion or when it creates a hostile work environment. Adverse consequences might be there if the victim does not consent to the conduct in question or raises any objection thereto.

Criminal Proceedings

Where such conduct amounts to a specific offence under the Indian Penal Code or under any other law, the employer shall initiate appropriate action in accordance with law by making a complaint with the appropriate authority. In particular, it should ensure that victims, or witnesses are not victimised or discriminated against while dealing with complaints of sexual harassment. The victims of sexual harassment should have the opinion to seek transfer of the perpetrator or their own transfer.

MEDICO-LEGAL ISSUES IN AIDS AND STD

AIDS and STD have raised a lot of medico-legal issues in India and abroad. The issues can be divided into:

- | | |
|------------|------------|
| 1. Medical | 3. Ethical |
| 2. Social | 4. Legal |

Medical Issue

The issue, which often raises controversy, is the rights of patients or victims of AIDS and STD. Every patient or victim has the right to receive treatment for the disease. AIDS testing is not compulsory in India. Nobody can be forced to go for such testing. However, government has the right to enforce it during screening tests for government jobs. It is a common knowledge that hospital workers can get infected while treating AIDS patients and can bring lawsuits for compensation. The patients can be referred to the designated hospitals in case of AIDS/STD where adequate facilities are provided to deal with such cases.

Social and Ethical Issues

In our society, carrying of AIDS/STD is a big stigma and doctors are duty bound to maintain secrecy to protect the identity of patients. They can disclose this information only after express consent of the patient or relatives in case of the deceased. However, in certain cases information can be divulged and this is called 'privilege communication'.

Privilege Communication

It is agreed that whatever information a doctor has acquired during treatment of that patient has to be kept confidential, but doctor has to perform his duty to society also. In such cases, disclosure of information is called 'privilege communication'. In this regard, we have to understand what is absolute and qualified communication.

1. **Absolute Privilege:** It applies to any statement made in the court of law or parliament or state assembly. It also extends to statement made to lawyer during preparation for a court hearing as whatever

has been said in these cases cannot be a ground for libel or slander.

2. **Qualified Privilege:** Any disclosure made by the doctor can be protected if following conditions are met:

- (a) The statement must not be malicious and must be in good faith to a person who has the right to receive it. For example, if a person suffering from STD intends to use public swimming pool, the doctor can make disclosure about his disease to the in-charge of the swimming pool but not to any other person.
- (b) Only relevant information needs to be conveyed to the appropriate authority and not the whole medical history of the individual. In 1998, the honourable Supreme Court of India passed an order in a case where a patient has sued the doctor as he has disclosed to his fiancée that he is suffering from AIDS and subsequently his marriage was cancelled on receipt of this information. The honourable Supreme Court observed 'So long as the person is not cured of the communicable venereal disease or impotency, the right to marry cannot be enforced through a court of law and shall be treated as suspended right, and if a person suffering from the dreadful disease like AIDS, knowingly marries a woman and thereby transmits the infection to that woman, he would be guilty of offences under Section 269 I.P.C. (negligent act likely to spread infection/ disease dangerous of life) and Section 270 I.P.C. (malignant act likely to spread infection/disease dangerous to life). Moreover, where there is a clash of the fundamental rights, as in this instance, namely, the doctor's right to privacy as part of right of life and the bride's right to lead a healthy life, which is her fundamental right under Article 21,

the right which would advance public morality or public interest, would alone be enforced through the process of law.

Legal Rights

Affliction of AIDS and STD raises a lot of legal rights of the victims. The victims may sue the assailant for damages and criminal intention. If a person in full knowledge of the fact that he is suffering from AIDS, sexually assaults a woman/man with added intention to infect her/him so that she/he will die, can also be booked under Section 307 (attempt to murder) or under Section 302 I.P.C. (murder) if person dies because of that along with different Sections like 269 and 270 I.P.C.

The presence of STD/AIDS on the sexual partner in case of married couple can be taken by the other spouse as a ground of divorce as it can be granted easily if this plea is taken in the court of law.

If a person gets AIDS during discharge of his professional duties as in hospital workers, he can sue hospital authorities if sufficient infrastructure facilities are not available. No worker can be discharged from services only on the fact that he is HIV (human immunodeficiency virus) positive, his other health parameters also have to be taken into consideration, if he is fit otherwise, he cannot be removed from service.

MEDICO-LEGAL ASPECTS OF SEXUAL OFFENCES

Rape Trauma Syndrome

After rape, woman passes through great mental trauma. According to Sutherland and Scherl, rape trauma syndrome consists of psychological responses in victims of rape, of shock, dismay and non-specific anxiety. Burgess et al. defined rape trauma syndrome in two stages:

- (a) *Immediate or an acute disorganisation phase* consists of emotional reactions of

several kinds like feeling of guilt and humiliation.

- (b) *A long term reorganisation phase* during which victim readjusts her life as far as possible. She may have nightmares and phobia during such time. In western countries, rape crisis centres are set up to deal with rape trauma syndrome. In such centres, psychological support is offered through counselling.

RAPE DURING SLEEP OR UNCONSCIOUSNESS

Under ordinary circumstances, it is not easy to rape a well bodied adult female unless she is thrown accidentally and is unable to move. She may be raped if she is exhausted. It is not possible to rape a woman if she is sleeping. It may be possible that she may allow a person to have sexual intercourse thinking that he is her husband. It is possible to rape a woman if she is unconscious either due to injury or drugs or alcohol. If a woman has voluntarily taken some drug or alcohol, and then gives consent under that influence, she cannot charge a man of rape.

Date Rape

Date rape is said to occur when a woman complains that she has been raped by her boyfriend when both of them have gone together for vacation or a stay at some place. She may allege that she has been given some drug or alcohol with an intention to get consent.

She may even say that she has been raped in a hotel room. In India, concept of date rape is not recognised although many western countries acknowledge it. In these cases, less severe punishment is given to the accused as it is assumed that the woman has given some sort of consent when she has gone for date with her boyfriend. There are various drugs available in the market which can be easily mixed in alcohol or food, which make a woman unconscious or

semiconscious and she may consent to sexual intercourse under the effect.

False Charges

Sometimes, false charges may be made against a person by introducing chilies into vagina of small children to produce congestion. In such cases, wash

sample should be taken from vagina and sent for chemical analysis. A seminal stain on genitalia or clothes may be simulated by a solution of starch or egg white.

A blood stain may be simulated by application of blood of some bird or animal. In all such suspected cases, samples taken would prove innocence of the accused.

CHAPTER 20

Legitimacy and Medico-legal Aspects of Marriage Annulment

DEFINITION OF LEGITIMACY

The legitimate child is one who is born out of wedlock or within a competent time after the cessation of marriage. Under Section 112 of the Indian Evidence Act there is a presumption that even after a lapse of 280 days of dissolution of marriage, a child birth is possible and the child can be considered legitimate. Duration of 280 days is not absolute. Even if a child has been born after 280 days, and supported by enough evidence, the child would be considered legitimate.

MEDICO-LEGAL ASPECTS OF LEGITIMACY

The question of legitimacy arises in the following situations:

1. **Disputed Paternity:** A woman may approach a court of law alleging that the paternity of her child should be fixed and allege that some particular person is the father of the child. She may claim compensation to bring up the child.
2. **Inheritance:** A child may approach a court of law through her/his mother to claim the property of her/his putative father.
3. **Fictitious Child:** A matter may be brought to the notice of the court that the mother has substituted a living child against a dead

born or feigned pregnancy to claim property.

Medico-legal Considerations

The medico-legal importance of pregnancy is as follows:

1. **Duration of Pregnancy:** The average duration of pregnancy is considered as 280 days or 40 weeks, although it may vary from woman to woman. The formula to calculate expected time of delivery is to add 9 months to the last menstrual day plus 7 days.
2. **Maximum Period of Pregnancy:** Although it is not exactly known to what period pregnancy can continue, in India, law does not fix any maximum limit of gestation. Cases have been reported where females have given birth even after 352 days from the last day of menstruation. Each case has to be evaluated on its own merits.
3. **Minimum Period of Pregnancy:** The child born on or after 210 days or 7 months is considered viable. However, cases have been reported where children born in even less than 210 days have also survived.
4. **Superfecundation:** It means fertilisation of two ova of the same period of ovulation by

two acts of sexual intercourse at different times. Such occurrence is very rare in human beings.

5. **Superfetation:** It means fertilisation of an ovum belonging to the subsequent cycle of ovulation when already one ovum from previous cycle is fertilised and is growing. Such occurrence in human beings is possible especially if it is a bipartite uterus.

6. **Paternity:** The question of paternity assumes great significance in cases of adultery, divorce, matrimonial disputes and property inheritance. The various tests by which paternity disputes can be sorted out are:

- (a) **Blood grouping:** By matching blood groups of child, mother and putative father exclusion of paternity can be possible in some cases. The common system of blood groups used are ABO, Rh and MNS system.
- (b) **HLA typing:** By HLA typing of blood, exclusion of about 98 per cent is possible.
- (c) **DNA fingerprinting:** This is most appropriate to fix paternity. It is 100 per cent reliable. This technique was devised by Alec Jeffreys of the U.K. In this, sequences of bases in DNA strands of chromosomes are used for comparison. It is now widely available in India.

MEDICO-LEGAL ASPECTS OF MARRIAGE ANNULMENT

According to the provisions of the Hindu Marriage Act 1955, Special Marriage Act 1954, Indian Divorce Act, Parsi Marriage and Divorce Act, any marriage solemnised under them can be declared null and void under following conditions:

1. Bigamy, i.e. if one spouse has made one more marriage.

2. Impotence.

3. If either party is underage.

4. If one spouse is having unsound mind at the time of marriage, virulent form of leprosy or venereal disease in a communicable form.

5. If one spouse has not been heard of as being alive for a period of 7 years or undergoing a sentence of imprisonment for 7 years.

The wife can also seek divorce if husband has been guilty in cases of rape, sodomy or bestiality.

Marriage can also be declared voidable:

1. If the consent has been obtained by coercion or fraud.
2. If the woman was already pregnant with someone else's child at the time of marriage.
3. On account of wilful refusal of either party to consummation of marriage by an act of sexual intercourse which is natural and complete.

Adultery

It means sexual intercourse between one spouse and a person of opposite sex, not his or her spouse, during subsistence of marriage.

It is punishable under law for a maximum sentence of up to 2 years. But in the crime of adultery, only the male is punished, woman is not punished. The cases of adultery can be proven by circumstantial evidences such as non-access of husband and birth of child. Contracting of venereal diseases from some person other than spouse, evidence of going to brothels are circumstantial evidences which point toward adultery.

Impotence

Impotence is a ground for divorce. But it must be present at the time of marriage, and continue to be present at the time of filing lawsuit.

Desertion

Wilful neglect for more than 2 years showing deliberate voluntary withdrawal from living together without the consent of spouse is a ground for divorce. If husband and wife have been living separately for more than 1 year, they can file for divorce on mutual consent.

Cruelty

Legally, cruelty is defined as danger to life, limb, physical or mental health, or a reasonable apprehension of such danger. Cruelty can be physical or mental.

Wife Battery

Some husbands routinely resort to physical violence to their wives usually after drinking.

In such cases, on medical examination, a woman may be seen having multiple injuries of various durations, suggesting that she has been beaten on more than one occasion. Abnormal sexual practices also amount to cruelty.

A special provision in Section 498A of the I.P.C. deals with cruelty, and states that “whoever, being the husband or the relative of the husband of a woman, subjects such woman to cruelty shall be punished with imprisonment for a term which may extend to three years and shall also be liable to fine”.

Infanticide

DEFINITION

Infanticide is defined as “an unlawful destruction of a newly-born child”. It is equivalent to a murder and is tried under Section 302 of the I.P.C. and is punishable. In many western countries there are separate laws on infanticide but in India it is not so. All the cases of infanticide are treated at par with murder cases.

Infanticide is quite common in India especially with the girl child. Due to social pressure and customs, the child is done away with within minutes to hours after birth. When the body of the child is detected, it is brought for post-mortem examination to the doctor. In such cases, investigating officer may raise following queries:

1. Was the child stillborn or dead born?
2. Was the child born alive?
3. If born alive, how long did the child survive?
4. What was the cause of death?

These queries are needed for investigation as the prosecution has to prove beyond doubt that the child was born alive before it was done away with. So, the doctor has to conduct post-mortem on the lines of the above queries.

WAS THE CHILD STILLBORN OR DEAD BORN?

Stillborn

World Health Organisation defines stillbirth as the child which has issued forth from the mother after

28 weeks of pregnancy and did not at any time after being completely expelled breathe or show any signs of life. It means that before birth, the child was quite well in uterus but died during the process of delivery. Stillbirths are quite common in poor people, illegitimate and immaturely delivered children. On post-mortem examination, no abnormality is found in most of the cases. The lungs would be found irrespirable but no signs of maceration are seen.

Deadborn

A dead born child is the one who has already died in the uterus long ago and may show following features due to putrefaction already begun *in utero*:

1. **Maceration:** It is a sterile process *in utero* as the air has not reached inside the uterus. Due to maceration, the body of the foetus becomes soft, flaccid and a peculiar sweetish disagreeable smell is present. The skin may be red in colour. Large blebs may be seen on the body which may exude serous fluid. Epidermis can be peeled off easily. The characteristic features are seen in cranial cavity where cranial bones are separated and may overlap each other. This feature can be seen by radiological examination and is diagnostic. The brain tissue is converted into a mass. The viscera inside the body starts losing their shape and

may reduce into a pulpy mass. On histological examination, evidence of phagocytosis may be seen. If air enters into liquor amnii due to rupture of membranes, the foetus goes into putrefaction rather than maceration.

2. **Mummification:** This is sometimes seen in conditions where the foetus dries due to deficient supply of blood from uterine vessels and liquor amnii is dried up. Air has not entered the uterus in such cases.

WAS THE CHILD BORN ALIVE?

According to Indian law, live birth is—when any part of living child has been brought out during delivery, though the child may not have breathed or been completely born. If a charge of murder has to be proved, it should be established that the child was born alive. Normally, the cry of the baby is considered as the sign of live birth but in some cases, the child may cry even while he is in uterus or vagina but dies when completely born. The evidence of live child birth has to be proved by the doctor in a court of law. The most important criteria that doctor has to establish is whether respiration has taken place or not. To determine this, the following criteria should be taken into consideration:

1. **Shape of Chest:** The chest becomes arched or drum-shaped after respiration has started, before which, it is flat.
2. **Diaphragm:** While conducting post-mortem to establish live birth, it is advisable to open abdomen first, so as to notice the position of diaphragm. It is found at the level of fourth or fifth rib if respiration has not taken place and its arch is concave. But once respiration has taken place, the arch becomes flattened and comes at the level of the sixth or seventh rib.
3. **Lungs:**
 - (a) **Volume:** Lungs are quite small with sharp margin before respiration is established. But once it is established, they grow in size and fill the chest and attain round margins.
 - (b) **Consistency:** Before respiration the lungs are firm, dense and liver-like and are non-crepitant. Once respiration is established, they become crepitant and spongy.
 - (c) **Colour:** Lungs are reddish-brown before respiration. If a cut section is made, it exudes frothless blood. But becomes rosy red in colour once respiration is established. On cut section, blood with froth comes out as alveoli are now filled with air.
 - (d) **Weight:** The lungs become double in weight after respiration due to air and inflow of pulmonary blood.

Hydrostatic Test

This is the most commonly done clinical test to know whether respiration has taken place or not. The specific gravity of the unrespired lung is more than one (1.04–1.05) while that of respired lung is less than one (0.94). Due to this fact, respired lung would float in water while unrespired lung would sink.

Procedure: First, both the lungs are removed along with trachea and larynx and are put in a glass vessel. It is to be noted whether they float or sink. Then they are separated and are individually tested whether they float or not. The lungs are cut into small pieces and are put to test for floatation. If these pieces float, they are squeezed between thumb and index finger in water to look for small air bubbles which come out. If the pieces continue to float and exude air, it means respiration has taken place. If some pieces sink and others float, it means feeble respiration has taken place. The following aberrations may be seen:

1. **False Negative Cases:** The lungs which have been expanded with air may sink due to following reasons:
 - (a) Diseases like bronchopneumonia may cause lungs to become heavy as the air in the alveoli may be replaced with acute oedema or pus.
 - (b) Diseases like atelectasis may cause nonentry of air into alveoli although air has entered into the respiratory column.
 - (c) Due to feeble respiration, sometimes air may not be able to reach the alveoli, so the lungs are not expanded although the child has respired.
2. **False Positive Cases:** The unexpanded lungs in these cases may float due to following reasons:
 - (a) **Putrefaction:** Putrefactive gases may cause floatation of the lungs. Signs of putrefaction on the rest of body may also be seen.
 - (b) **Artificial respiration:** If a child has not started taking respiration immediately, he is put on artificial respiration and air is made to enter the lungs forcefully. This air, after entering alveoli, may cause floatation of lungs later on when the child is declared dead.

When Hydrostatic Test is not Needed

In the following conditions, there is no need to conduct a hydrostatic test:

1. When foetus is below 180 days of gestation.
2. When there are congenital malformations which make life impossible, like monster child.
3. Signs of intrauterine maceration seen.
4. The umbilical cord is separated from the naval which shows signs of cicatrisation.
5. Stomach has presence of food, or water can be demonstrated in small intestine.

Changes in stomach and intestines

When respiration is established and the child begins to cry, a small amount of air enters into the stomach within 5–15 minutes of birth. This small amount of air can be detected in the small intestine after 1–2 hours. A portion of this air also passes into the large intestine after a gap of 5–6 hours. The air in stomach, small intestine and large intestine can be demonstrated by dissecting them under water. This is also known as **Breslau's second life test**. This test is useless if putrefaction has started or an effort has been made to give artificial respiration.

If water, or food is detected in stomach or small intestine, it is proved that the child has lived for some time.

IF BORN ALIVE, HOW LONG DID THE CHILD SURVIVE?

From the following changes, some idea can be had, of how long did the child survive before dying:

1. **Changes in the Skin:** The vernix caseosa is present all over the body in a newborn child, and remains there up to 24 hours. The colour of a newborn baby changes from bright red to a darker one in 2–3 days and the baby assumes normal colour in 7 days.
2. **Caput Succedaneum:** It is prominent at the time of birth, more so in deliveries done by forceps. It disappears in 2–3 days.
3. **Umbilical Cord Changes:** At the time of birth, umbilical cord is cut and clotting in the cut-end stops in 2 hours. The cord starts drying in 24 hours. It starts to shrivel in 3–4 days and finally falls off on 5th–6th day, leaving an ulcer which heals in 10–12 days.
4. **Changes in Circulatory System:** Umbilical vessels start obliterating as they are not required. They close in about 3 days. The foetal haemoglobin also starts reducing. The ductus arteriosus closes in 10 days. The foramen ovale closes in 2nd–3rd month.

WHAT WAS THE CAUSE OF DEATH?

The cause of death could be natural, accidental, or homicidal.

1. **Natural Causes:** The following are the natural causes:
 - (a) **Immaturity:** It is one of the commonest reasons where child is born before full gestation.
 - (b) **Congenital diseases:** Death could be due to syphilis or plague.
 - (c) **Malformations:** Monster child like acephalous or anacephalus may not survive longer.
 - (d) **Haemorrhage:** Haemorrhage occurring due to placenta previa or any other reason from uterus, umbilical cord or vagina can cause death of foetus or mother.
 - (e) **Rh incompatibility:** This is also one of the reasons for death.
2. **Accidental Causes:** Accidental death of the child can occur during birth or after that. During birth, death may occur due to:
 - (a) **Prolonged labour**
 - (b) **Prolapse of cord**
 - (c) **Strangulation** due to knots around the neck by umbilical cord
 - (d) **Inadequate pelvis:** Pelvis size may be smaller, or the child is bigger.
 - (e) **Injuries:** Heavy blows on the abdomen of a pregnant woman can cause death of foetus. In such cases, the woman may start bleeding immediately after the blows. Child may get injured while coming out of pelvis. Child may get injuries sometimes, if delivered by forceps.
 - (f) **Death of mother:** If mother dies accidentally during labour or otherwise, child in the uterus would die if not taken out immediately. The child may die after birth because of following reasons:

- (i) **Suffocation:** The child may die of suffocation if respiratory passages are not clear due to presence of blood, meconium or liquor amnii. Suction should be initiated immediately to save the child. A child may also die of suffocation, if he/she is wrapped closely in clothes.
- (ii) **Precipitate labour:** In this, a child is born without the mother's knowledge and child may fall on ground or lavatory pan and may get injuries. Such labour is possible in a multiparous woman with a roomy pelvis, or if the child is quite small and can come out without effort. Precipitate labour is not common.

HOMICIDAL OR CRIMINAL CAUSES

The child may die because of:

1. **Act of Commission:** When wilful mechanical violence is used to kill the child or the child is poisoned.
2. **Act of Omission:** It is due to neglect of the child.

Act of Commission

- (a) **Suffocation:** On birth, the child is killed by applying pressure by a pillow or soft tissue or introducing foreign body in the respiratory passage. The child may also die if the mother overlays intentionally over the child. The child may also be suffocated while applying pressure on chest.
- (b) **Strangulation:** It is also a common method of killing a small child. A ligature like pyjama, tape or any cord may be used. Sometimes, umbilical cord is used to strangle, to mimic natural death. Child may well be throttled.
- (c) **Drowning:** In some communities the child, especially a female child, is killed by

plunging the face into milk so that milk is aspirated into respiratory passage causing death. This custom is called “**Dudh Pita Karna.**” Sometimes, a live child may be thrown in a river or pond to kill him/her, or a child may be thrown into water often first killing him/her by strangulation or suffocation.

- (d) **Mechanical violence:** The child may be killed by hitting her/his head with an object causing fractures or head injury. The fracture/dislocation of neck may be caused by forcibly rotating the head of the child. The child may also be killed by inflicting fatal injuries by sharp-edged weapon.
- (e) **Poisoning:** A small child can easily be killed by giving poisons such as opium.

Act of Omission

Failure to take proper precautionary steps during child birth are acts of omission. The following are some of the examples:

- (a) Omission to take proper medical care. It is presumed that the woman who is going to deliver has contacted a medical practitioner or paramedical staff in advance to take care of her and her baby during delivery.
- (b) Omission to ligate the cord after the cord is cut, otherwise haemorrhage may bleed the child to death.
- (c) Omission to remove child from the discharges from mother and failure to remove the discharges present in respiratory passages by suction.
- (d) Omission to protect from cold or heat of the environment.
- (e) Omission to provide proper food and care to the newborn child.

Relevant Legal Sections

1. Section 317 of the I.P.C. provides punishment for a maximum term of seven

years or fine, or both, for any person who exposes a new born child to any place with the intention of abandoning it and death does not supervene. The offender would be punished for murder if death occurs.

2. Section 318 of the I.P.C. defines punishment for a maximum of 2 years or fine or both in cases where the mother is charged with concealment of birth by secretly burying or otherwise disposing off the dead body of the newborn child.

Caffey’s Syndrome

It is also known commonly as ‘battered baby or, child abuse syndrome’. They are usually small children often less than one year but may be less than 4–5 years of age. They usually have multiple injuries of various durations. It suggests that the child has been beaten many a times over a certain period of time. They may have multiple rib injuries, multiple bruises over various parts of the body. Usually, parents deny any injury happening to child accidentally. These children usually come from problem families having multiple problems like parental maladjustment, foster parents, alcoholism or poverty in family. Sexual abuse of the child may also be seen in such cases.

SUDDEN INFANT DEATH SYNDROME OR COT DEATHS

These are unexpected unnatural deaths seen in young infants. They are found dead in the morning with no previous history of illness. They are commonly seen in the age group of 1–6 months, most commonly at 3 months. The incidence is around 1–2 per 1000 live births. On post-mortem examination, no obvious cause is seen. Although the exact reason of such deaths is not known but the following are some of the hypotheses advocated by some authors:

1. **Sleep Apnoea:** In such cases there may be prolonged apnoea during sleep causing death.
2. **Chronic Viral Infections:** They may cause sudden death with no obvious clinical findings.
3. **Autoimmune Reaction:** Some autoimmune changes in the body may induce sudden death. Sudden infant death syndrome is now a recognised clinical entity and is under WHO classification of natural cause of death.

CHAPTER 22

Abortion and Medical Termination of Pregnancy

DEFINITION OF ABORTION

It means spontaneous or induced termination of pregnancy before the foetus is viable. Normally, the foetus becomes viable after 20 weeks of pregnancy. But sometimes, children born before 20 weeks of pregnancy have also survived. With better medical facilities available now, it is possible to save premature babies more easily and more often.

'Abortion' usually refers to expulsion of fertilised ovum within 3 months of gestation. If expulsion occurs between 4–7 months of pregnancy, it is called 'miscarriage'. Premature baby is defined as a baby who comes out before full-term but usually after 7 months of pregnancy. It takes about 7–10 days for fertilised ovum for implantation. Up to 9th week, the fertilised ovum is called 'embryo' thereafter, it is called 'foetus'.

CLASSIFICATION OF ABORTION

Abortion is classified into following categories:

1. **Natural Abortion:** It is called 'spontaneous abortion' too and commonly occurs within 3 months of pregnancy. About 10–15 per cent of all pregnancies are aborted within 3 months of pregnancy.

The following are the common causes of natural abortion:

- (a) Acute systemic infections like respiratory or abdominal infections.
 - (b) Hypertension, diabetes mellitus and systemic diseases.
 - (c) Blood disorders like anaemia, Rh incompatibility.
 - (d) Blunt trauma to abdomen.
 - (e) High anxious states like sudden shock, fear, joy, sorrow or emotional set-up.
 - (f) Acute infection of vagina, uterus or ovaries.
 - (g) Congenital malformation of uterus, fibroids, etc.
 - (h) Genetic abnormalities of foetus.
 - (i) Idiopathic.
2. **Induced Abortion:** It may be of following types:
- (a) **Therapeutic abortion:** This abortion is done by a medical practitioner under the ambit of Medical Termination of Pregnancy Act 1971 at a place duly authorised by law. Under the Act, a pregnancy can be legally terminated on following grounds:
 - (i) *Therapeutic grounds:* It applies when the continuation of pregnancy would endanger the life of the woman, or would cause grave injury to her physical or mental health. In this case, pregnancy can be terminated at any stage.
 - (ii) *Eugenic:* Eugenic grounds involve the risk of child being born with serious physical or mental abnormalities like

anencephaly, big head, Turner's syndrome, Down syndrome, etc.

- (iii) *Humanitarian*: If the pregnancy has been caused by rape, it can be terminated under humanitarian grounds.
- (iv) *Social grounds*: Social grounds apply for termination in case of a married woman where:
 - Pregnancy has resulted due to failure of contraceptive methods adopted.
 - Continuation of pregnancy can cause injury to physical or mental health of the woman by changing social or economic environment.

The termination of pregnancy has to be done at a government hospital or any nursing home or hospital duly authorised by government authorities. If the duration of pregnancy is less than 12 weeks, one registered medical practitioner can terminate it. But if the pregnancy is above 12 weeks but less than 20 weeks, two medical practitioners are required for termination. No pregnancy above 20 weeks can be terminated except when warranted to save the life of the woman (under therapeutic grounds). The registered medical practitioners conducting the termination of pregnancy must be registered with medical council and be duly competent to conduct abortion. A medical practitioner with M.D. degree in obstetrics and gynaecology or diploma in gynaecology and obstetrics or MBBS degree holder who has assisted in at least 25 cases of medical termination of pregnancy under supervision is competent to perform abortion under the Act.

The place where termination is done should be well equipped with facilities for the operation and administration of anaesthesia and should be recognised by competent authorities.

Consent: Consent of the woman is mandatory except when she is minor or

mentally ill. In such cases, consent from parents or guardians can be taken. Consent of the husband of the married woman is not necessary.

Emergency cases: In case of emergency any registered medical practitioner of any specialty irrespective of obstetrics and gynaecology can terminate pregnancy at any place, irrespective of duration if it is done to save the life of the pregnant woman.

- (b) **Criminal abortion:** When the abortion is not done as prescribed under Medical Termination of Pregnancy Act, it is called 'criminal abortion' and is punishable under law.

Most of the criminal abortions are done within first 3 months of pregnancy. In India, female foeticide is very common as some people have a strong desire for male child. They keep on doing female foeticide till the woman is pregnant with a male child. In some communities where dowry demands are quite high, female foeticide is very common. They get to know the sex of the foetus by ultrasound. The sex of the baby is differentiated at 4 months of gestation and can be easily detected by ultrasound. If the foetus is a female, parents opt for abortion. In order to prevent foeticide, the Government of India has banned ultrasound examination for detection of sex under the Pre-conception and Pre-natal Diagnostic Techniques (Prohibition of sex selection) Act, 1994.

In poor families, criminal abortion is common as they cannot afford to go to private clinics for abortion, and opt for unskilled health workers for abortion. Although in a government hospital there is no charge for MTP, still abortion by unskilled workers is quite common in India.

WHO has defined 'unsafe abortion' as abortion not provided through approved facilities and/or persons.

Unsafe abortion is very common in India. Section 312 of the I.P.C. defines 'causing miscarriage' as an abortion done is not in good faith and will be punishable with a sentence ranging from 3 to 7 years, even if the abortion is done with the consent of the woman. Section 313 of the I.P.C. states whoever conducts an abortion without consent of the woman may get imprisonment from 10 years to life imprisonment. Section 314 states that if a person causes death of a woman while doing miscarriage without her consent, he can be punished up to life sentence and if he is doing with consent of woman, he can be punished up to 10 years.

INDUCTION OF ABORTION

Methods of Inducing Abortion under MTP Act

Under the MTP Act the following methods can be used for inducing abortion:

1. **Medical Method:** It can be done up to 49 days or less. In this, the patient is given 600 mg of Mifepristone as a single oral dose. It is followed by 400 µgm of Misoprostol as a single dose after 2 days. Bleeding follows and products of conception are expelled. Patient should be advised to follow up after 14 days for confirmation of termination of pregnancy. Adverse effect include excessive bleeding, vaginitis or uterine haemorrhage. It is contra indicated in confirmed or suspected ectopic pregnancy.
2. **Surgical Methods:** The surgical methods used for inducing abortion are as follows:
 - (a) **Vacuum Aspiration:** It is a very common method in which the products of conception are aspirated by vacuum. It is ideal for pregnancy up to 12 weeks of gestation.
 - (b) **D and C (dilatation and curettage):** It is practised till 20th week. In this, the cervical canal is dilated and probe is introduced in

uterine cavity, and curettage is done in uterine wall to remove products of conception.

- (c) **Hysterotomy:** It is done in cases where sterilisation is also desired along with abortion.
 - (d) **Hysterectomy:** It may be performed in an elderly patient. In this, uterus is completely removed.
3. **Other Methods:** The following methods also cause abortion but nowadays they are not practised.

Medical methods: In this, hypertonic saline, urea or rivanol, and prostaglandins are placed intrauterine, which enhance uterine contraction and cause products of conception to be expelled.

Complications of MTP

The complications that might occur during MTP are, as follows:

1. **Immediate Complications:** Include haemorrhage leading to shock, even death, perforation of uterus, vagina or intestine, endometritis and sometimes there may be incomplete abortion when some products of conception are still retained in the uterus.
2. **Late Complications:** Include sterility, menstrual disturbances, etc.

Methods of Inducing Criminal Abortion

Generally, there are two methods to induce criminal abortion:

1. **Drugs:** The following are the common drugs used for abortion and are commonly called 'abortifacient drugs':
 - (a) **Ecbolics:** These drugs act on pregnant uterus and cause contraction to expel the products of conception:
 - (i) Ergot preparations
 - (ii) Synthetic oestrogens
 - (iii) Strychnine

- (iv) Quinine
- (v) Pituitary extract.

They are required to be given in high doses and cause systemic side effects.

- (b) **Emmenagogues:** These drugs increase menstrual flow and can be used for inducing abortion. Common examples are borax, sanguinarin, oestrogen preparations, savin, etc.
- (c) **Irritants:** Common genitourinary irritants like cantharides, oil of turpentine, or oil of tansy can be used to stimulate pregnant uterus to expel products of conception. Other gastrointestinal irritants which increase bowel movement like castor oil, senna, croton oil, purgatives cause abortion as they can increase uterine contractions.
- (d) **Systemic poisons:** Some systemic poisons like arsenic, phosphorus, mercury, *Abrus precatorius*, calotropis and plumbago are also used to induce criminal abortion.
- (e) **Abortion pills:** Abortion pills made of lead, diphenylethylene are sometimes used.

2. **Violence:** It may be local violence or general violence:

- (a) **General violence:** It is commonly used in first month where a violent activity may induce uterine contraction and cause abortion. Commonly, severe forms of exercise, excessive cycling, riding, jumping, and alternative use of hot and cold bath may induce abortion. Violent massage on the abdomen and violent pulling of abdominal wall may cause abortion.
- (b) **Local violence:** This is commonly used in third or fourth month. Violent punching in the abdominal area may cause abortion. Unskilled or semi-skilled workers use instruments locally to induce abortion.

3. **Unskilled Abortion:** In India, unskilled abortion is quite common among poor classes. Because of

lack of education and means to afford good medical care, they become susceptible to unskilled workers commonly called *Dais*. Anything which can penetrate through cervix like needle, hairpin, pencil, etc., may be used. An instrument commonly used by *dais* is called '**abortion stick**'. It is usually a thin wooden or bamboo stick about 15–20 cm long. On one end, irritant juice of marking nut or paste of arsenic, red lead or asafoetida is applied on a cotton and is introduced into the uterus through os of cervix. Because of irritation due to juices or rupture of membranes due to force of stick, the products of conception are expelled out. It is usually followed by haemorrhage or sepsis and woman may die in such a process. Every year, thousands of women die in India because of this. The abortion stick may sometimes cause perforation in uterus or intestine or urinary bladder and may cause further complications.

Sometimes, water or irritants may also be introduced in the uterus through syringes.

Causes of Death Due to Criminal Abortion

Death in criminal abortion occur in following ways:

1. **Immediate Causes:** It may be:

- (a) **Vasovagal shock:** It may be due to high state of anxiety in the woman or due to introduction of a syringe or stick.
- (b) **Haemorrhage:** It is the most common immediate complication. It may be due to damage of uterine vessels.
- (c) **Air-embolism:** It may occur if vessels of the uterus are exposed to air when the stick is introduced and air also travels with it.

2. **Late complications:** These included:

- (a) **Sepsis:** It is the most common late complication. Infection may occur while abortion is done and may cause death if not controlled.

Table 22.1 Difference between nulliparous and parous uterus

	<i>Nulliparous uterus</i>	<i>Parous uterus</i>
1. Size	Small (7 cm × 5 cm × 2 cm)	Large depending on period of gestation
2. Weight	35–40 gm	May be 30–100 gm
3. Uterine cavity	Cavity appears triangular, walls are convex	Walls are concave, bigger oval appearance
4. Upper surface	Almost horizontal	Convex
5. External os	Small roundish	Transverse slit-like opening
6. Internal os	Circular and well defined	Ill-defined
7. Ratio of body and cervix	50:50	66:33
8. Placental attachment	None	Scar may be seen

(b) **Sterility:** In some cases, sterility may occur if uterine mucosa is also denuded at the time of operation.

(c) **Uterine adhesions:** These may also occur.

Medico-legal Significance

A doctor may be called upon to opine on:

- (a) Whether a woman has aborted recently.
- (b) Examination of a dead woman who may have died during criminal abortion.

Signs of Recent Abortion in Living

A woman who has recently aborted may show the same signs as found in a pregnant woman of the same gestation. In this, local examination should be carefully done. A slight discharge may be seen. The cervical os may show some discharge and slight opening. Some tears in vagina due to application of instruments, may be seen. If a woman has recently delivered, her general physical condition remains bad for 1 or 2 days.

Examination of Dead Woman Who has Died of Criminal Abortion

Here, the signs of pregnancy would be visible outside the body corresponding to the period of gestation. Breast may show enlargement. Woman's

body may appear pale if she has died of haemorrhage. Local examination is very crucial (Table 22.1). Examination of vagina and uterus may be done for injury, presence of products of conception, foreign body like pin, abortion stick, discharge, etc. If death has occurred due to air embolism, signs of embolism may be present. If death has occurred due to sepsis, pus may be seen in uterine cavity. Sometimes, perforation of uterus or intestine may be seen.

Examination of Aborted Material

The doctor may be asked to opine sometimes on the aborted material to know the age, sex and development of the aborted foetus. The aborted material should be examined carefully as the foetus may be in multiple pieces due to instrumentation. To determine the age of the foetus, there is generally a rule called **Haase's rule**, which states that to know the age of foetus up to 5 months, the square root of the length of the foetus should be taken while after 5 months, the length of the foetus should be divided by 5 to know the age in months. So, up to 25 cm of length of foetus (about 5 months of gestation) the square root should be applied to know the age in months. Above 25 cm of foetal length it should be divided by 5 to know the foetal age in months. The following developments in the foetus should be remembered to know the developmental cycle:

1. **First Month:** Length is about 1 cm. Eyes as dark spots can be seen. Very short cord can be seen. Mouth is seen as cleft. If abortion is done at this stage, embryo can be missed in blood clots as it is very small.
2. **Second Month:** Length is about 4 cm. Mouth and nose are separated. Anus appears as a dark spot. Sex is indistinct. Centres of ossification are seen in mandible, clavicle, ribs, vertebrae.
3. **Third Month:** Length is about 9 cm. Placenta is developed. Head is separated from the body by the neck. The eyes and mouth are closed. The sex is still not clear. Centres of ossification are seen in in most bones. The heart is divided into two chambers.
4. **Fourth Month:** Length is about 16 cm. Weight is 100 gm. Sex can be differentiated. The skull bones are partly ossified. Foetus can be seen on X-rays. The gall bladder is forming.
5. **Fifth Month:** Length is 25 cm, weight is 300 gm. Hair seen on scalp. The centres of ossification are seen in os pubis. Bile is seen.
6. **Sixth Month:** Length is 30 cm, weight is 700 gm. Centres of ossification are seen in sternum. Eyelashes start appearing.
7. **Seventh Month:** Length is about 35 cm, weight 1400 gm. Centres of ossification commence to form in talus. Generalised development is seen.
8. **Eighth Month:** Length is 40 cm and weight is 2 kg. The centre of ossification is seen in last vertebrae of sacrum. This month, the foetus becomes viable from medico-legal point after 210 days.
9. **Ninth Month:** Length is 45 cm, weight is 2.5 kg. The scrotum receives the two testes. Centre of ossification in lower epiphysis of femur is present.
10. **Tenth Month:** Mature child is ready for independent existence. Length is 50 cm and weight is about 3 kg.

CHAPTER 23

Insanity and Forensic Psychiatry

DEFINITION OF INSANITY

The word “insane” has no technical meaning and is commonly used to refer to individuals who cannot take care of themselves or adhere to the social fabric, due to some mental disorder. It refers to individuals who by virtue of being mentally ill, are not competent to discharge their legal duties and are not aware of the legal implications of their behaviour. In the Indian Penal Code, the phrase ‘unsoundness of mind’ is used as synonymous to terms such as insanity, lunacy, madness or any mental disorder where a person is not capable of regulating his behaviour according to the socio-legal system.

A medical officer is often called upon to opine whether a person is insane or not. He should not opine in a hurried manner, instead he should examine the person in detail and then express his opinion.

CAUSES OF INSANITY

The potential causes of insanity are as following:

1. **Heredity:** Insanity often runs in families. The exact reason is not known. Usually, most of the mental diseases are not transmitted genetically but it has been observed that mental illness runs in families.
2. **Environmental Factors:** If during the early years of childhood, the upbringing of a child is not taken well care of, there are chances

of developing mental illness. Attitude of both parents is very important in shaping good personality. Over protection, rejection, unnecessary peer comparison, or sibling rivalry can cause maladjustment in a child. Emotional maladjustment is quite common in adolescent period. A good sex education is very essential for adolescents to fashion their personality according to the social fabric. In adults, domestic quarrels, financial and business losses, failure in love, death of near ones, unemployment and job pressures can precipitate mental illness.

3. **Organic Causes:** Head injuries like cerebral haemorrhages, high fever and epilepsy may induce mental disorder. Addiction to alcohol, opium and dhatura may induce violent behaviour. Addiction to severe narcotics like heroin, cocaine and LSD may cause anti-social behaviour, and the person may commit crime. In severe, systemic diseases like uncontrolled hypertension, diabetes or other debilitating diseases, the person may land up in depression.

ONSET OF INSANITY

The onset of insanity is gradual. The person may be brought to the medical officer for treatment. In some cases the person may malingering to avoid punishment. So, the medical officer has to decide whether insanity is true or false (Table 23.1).

Table 23.1 Differences between true and feigned insanity

<i>Features</i>	<i>True insanity</i>	<i>Feigned insanity</i>
1. Onset	Usually slow but rarely sudden	Always sudden
2. Motive	No motive seen	Motive may be there
3. Precipitating cause	May be there	Usually absent
4. Physical features	Typical of illness, looks are vacant, agitation may be seen, excitation or depression may be there	Person appears normal, looks are normal, over-reaction may be seen
5. Signs and symptoms	Usually point to a particular illness like MDP, depression, schizophrenia	Signs and symptoms keep on changing
6. Observation	If left alone, signs and symptoms remain as such	Signs and symptoms disappear if the person thinks that he is not being observed
7. Physical activity	Depends on the type of illness, but person is not exhausted	Person exhausts easily
8. Associated manifestations	Anorexia, not proper eating, insomnia may be seen	None
9. Personal hygiene	Usually very bad and filthy	Personal hygiene is good
10. Medical examination	Does not mind repeated examination	Resents multiple examinations
11. Recovery	Depends on the type of mental illness, usually slow	Very fast recovery seen if person is granted bail or released from the mental hospital

CLASSIFICATION OF MENTAL DISEASES

The classification of mental diseases is done according to two well-accepted methods which are as follows:

1. **DSM IV:** This is an American system. It stands for Diagnostic and Statistical Manual of Mental Disorders, IVth edition 1994.
2. **ICD-10:** It means international classification of diseases, injuries and cause of death, 10th edition, 1992. ICD-10 classification is more popular and is followed worldwide.

The following is the classification of mental diseases according to the World Health Organisation:

1. **Psychosis (Major Illness):** It may be of following types:

- (a) **Organic psychosis:** When there is an organic cause associated with psychosis, it is called 'organic psychosis'. Common examples are alcoholic psychosis, psychosis following head injury, endocrine disturbances, old age, epilepsy, drug dependence, etc.

- (b) **Functional psychosis:** In this, there is no apparent cause of psychosis. It is of following types:
 - (i) Schizophrenia.
 - (ii) Manic-depressive illness.
 - (iii) Paranoid state.

2. **Neurosis (Minor Illness):** The following are the common types of neurosis:

- (i) Anxiety neurosis.
- (ii) Depression.
- (iii) Hypochondriacal.

- (iv) Obsessive compulsive neurosis.
- (v) Hysterical neurosis.

3. **Personality Disorders as in Psychopaths.**
4. **Sexual Perversions.**
5. **Drug Dependence.**

Before going into details of mental diseases, let us understand common terms used in forensic psychiatry:

1. **Abreaction:** This is a release phenomenon where old, forgotten things or events are brought into conscious state again.
2. **Affect:** It is commonly called mood or feeling.
3. **Amnesia:** Loss of memory about a person or event is called 'amnesia'.
4. **Aphasia:** Loss of sensory or motor ability to express by use of speech or writing is called 'aphasia'.
5. **Binet-Simon Test:** It is done to determine the intelligent quotient of an individual.
6. **Circumstantiality:** When a person is not able to answer properly, in a straight manner, and keeps on giving irrelevant details or wanders off the subject many times in a conversation, the condition is called circumstantiality.
7. **Compulsion:** It is a repetitive behaviour done by an individual in spite of knowing that it is not correct. Examples being, repeatedly washing hands, checking locked premises again and again.
8. **Delirium:** It is an altered state of consciousness. The mental faculty of an individual does not work properly. It may be seen in high grade fevers (organic delirium) or in different psychological problems (functional delirium).
9. **Delusion:** It is a false belief which remains even when confronted with material facts. The person is not convinced by any reason or logic.

Following are the common types of delusion found in clinical practice:

- (a) **Delusion of grandeur:** The person thinks he is very rich, powerful and may squander away his money or property. This is a pleasant delusion.
 - (b) **Delusion of persecution:** The person thinks that people are after him and may kill him, or harm him. The person remains suspicious and depressed and may commit some crime.
 - (c) **Delusion of reference:** The person thinks that everybody is thinking about him only, and this may put him in conflict with the world.
 - (d) **Hypochondriacal delusion:** The person in this delusion thinks that he is ill always, while medically he may be completely fit. He keeps on visiting doctors. Usually the person gives vague abdominal complaints.
 - (e) **Delusion of infidelity:** In this, the person thinks that his/her spouse is not loyal to him/ her. Usually, males suffer more from this delusion as compared to females. The person may commit crime in this state.
 - (f) **Nihilistic delusion:** In this, the person does not believe that the world exists and may commit suicide or kill others. Medico-legally, delusions are very important as they affect the behaviour of an individual and he may come in conflict with law or society. The responsibility of the individual committing crime under delusion has to be fixed in accordance with the law.
 - (g) **Erotomania:** In this, a women thinks that a particular person, especially superior, is in love with her.
 - (h) **Pseudologia fantastica:** This is a variation of Munchausen's syndrome in which a person feels convinced that he is seriously ill and keeps on visiting many doctors in vain.
10. **Fugue State:** The person becomes a wanderer who keeps on moving from place to place in an altered state of mind. He has

episodes of amnesia. This stage is seen in depression, schizophrenia and other mental disorders.

11. **Hallucination:** It is a false sensory perception which manifests without any cause or objective or stimulus. They are usually of the following types:

- (a) **Auditory hallucinations:** Here, the person hears voices of known or unknown persons. They are quite common in schizophrenia. In some cases a person hears a command from God or Satan to do certain acts which may land up the person in conflict with law.
- (b) **Visual hallucinations:** The person may see lights or images or scenes. Such hallucinations are quite common in schizophrenia, epilepsy and drug withdrawal syndromes.
- (c) **Olfactory and gustatory hallucinations:** Such hallucinations involving smell and taste are quite common in organic brain disease, depression, etc.
- (d) **Tactile hallucinations:** They are commonly seen in cocaine addiction where bugs seems to be creeping in layers of skin.

Hallucinations are very important from the medico-legal point of view as mostly, hallucinations pin-point to a major mental illness, although physiological hallucinations usually at the time of sleep or arousal are reported in normal individuals.

- (e) **Lilliputian:** In this a person perceives objects to be of a much smaller size than they actually are.
 - (f) **Synaesthesia:** In this, a person perceives a different sensation from a different organ like he may visualize music or hear different colours.
12. **Illusion:** It is false perception due to distortion of real sensory stimulus. Optical illusions are quite common in deserts where

water may be seen at places. A rope may be seen as a snake at night. Illusions are usually of three types:

- (a) **Completion illusion:** Where an unfinished pattern is completed by illusion.
- (b) **Affect illusion:** In this, mood of the person affects the nature of illusion.
- (c) **Parabolic illusion:** When human faces or images are seen in illusion. In illusion, the person may be corrected when confronted with facts. He realizes that it was a misinterpretation of stimulus.

13. **Impulse:** This is defined as a sudden and irresistible force which compels a person to do some action without motive or thinking. Normally, a normal person always tries to analyse his actions whether they are consistent with law or not. Once he realises that his action may be contrary to law he stops it. But in impulse, a person is not able to control himself.

The following types of impulses are seen in clinical practice:

- (a) **Kleptomania:** An irresistible desire to steal things usually of low value.
- (b) **Pyromania:** An irresistible desire to set things on fire.
- (c) **Mutilomania:** An irresistible impulse to maim animals.
- (d) **Dipsomania:** An irresistible impulse to drink at periodic intervals.
- (e) **Sexual impulses:** All sexual perversions.
- (f) **Homicidal impulses:** To kill some persons.
- (g) **Suicidal impulses:** To commit suicide. Impulses are quite commonly seen in various mental disorders like depression, schizophrenia, mania, etc.
- (h) **Trichotillomania:** It is an irresistible desire to pull out one's own hair.

14. **Lucid Interval:** It is a phase of sanity between two episodes of insanity. In this, the person is completely normal and is

- legally answerable for all his actions. He can execute will or do any testamentary instruments. Lucid interval is commonly seen in manic-depressive psychosis. It has great medico-legal significance.
15. **Obsession:** An obsession is defined as a persistent and irresistible thought, image, affect or impulse that cannot be removed by the sufferer although he knows that this is foolish. He continues to suffer. When this converts into action, it is called '**compulsions**'. The person keeps on repeating foolish behaviour though realising that it is untrue. Normal persons also sometimes have obsessions but they overcome them over a period of time. But once it becomes pathological, it may turn into obsessive compulsive neurosis. The common examples are:
- the person may keep on checking the locks even though he knows that he has bolted them well.
 - The person may keep on washing hands for hours.
16. **Phobia:** It is an excessive or irrational fear of an object or situation. Common phobia include:
- Claustrophobia: Fear of enclosed spaces.
 - Agoraphobia: Fear of open spaces.
 - Fear of flying in aircraft.
 - Fear of animals, snakes, lizards.
17. **Psychosis and Neurosis:** There are differences commonly seen between these two main mental illnesses (Table 23.2).
18. **Psychopath:** It refers to individuals who have psychopathic personality. They are usually antisocial and have long criminal records. They have no remorse feeling and are not amenable to counselling. Some of them have extra Y chromosome in their chromatin.
19. **Dementia:** It is defined as degeneration of mental faculties once they have been fully developed. Dementia can occur at any stage of life. Usually, higher functions of life are impaired. Dementia may be due to old age (senile dementia), Alzheimer's disease, head injury, epilepsy, alcohol, etc. Usually, persons suffering from dementia remain within social fabric without breaking the law.
20. **Mental Handicap:** It refers to mental sub-normality in an individual, acquired at the time of birth or early childhood. Intelligent quotient is low. It is usually of the following types:
- Idiocy:** Here, I.Q. level is around 20. The person is mentally retarded severely. He may be associated with some other genetic problems too. He may need physical and mental rehabilitation to lead a normal life. Usually, idiots remain cheerful as their achievement goals are almost absent and they can lead their life easily on a survival basis.
 - Imbecile:** Their I.Q. level is between 20 and 50. They are incapable of managing their affairs themselves. They also require physical and mental rehabilitation by a therapist to lead a normal life.

Table 23.2 Difference between psychosis and neurosis

	<i>Psychosis</i>	<i>Neurosis</i>
1. Severity	Major	Minor
2. Genetic predisposition	Present	Absent
3. Insight	Person says he is well and does not require treatment	Person feels that he is ill and needs treatment
4. Contact with reality	Lost	Present
5. Empathy	Lack of empathy	Present

- (c) **Feeble mindedness:** Their I.Q. level is between 50 and 75. They appear normal but their mental faculties, especially intelligence, is less as compared to a normal person. They are usually school dropouts. They do not fare well in academic and financial career. They may get easily involved in criminal activities.

Psychosis

Psychoses are usually of the following two types:

1. **Manic-depressive Psychosis:** It is expressed in following two phases:
 - (a) **Mania phase:** In this, the person is very active, full of life, talking too much, mostly irreverent, the mood is elated and he does some action continuously. But he does not have touch with reality. He can commit any crime during this phase. Sleep is very less. Appetite is also less.
 - (b) **Depressive phase:** It is just the reverse of mania. The person is very sad, mood is depressed. The person sits alone and may speak very little. Touch with reality is not there. He may commit suicide. The motor functions are also quite depressed. A person suffering from manic-depressive psychosis may fluctuate between the two phases of mania and depression. It may be possible that the person may be normal between the two phases of mania. This may be lucid interval and the person is completely responsible for his actions.
2. **Schizophrenia:** Literally it means disintegration of mind. Commonly also called 'split personality'. The exact reason of schizophrenia is not known but it runs in families. There is a complete loss of reality. Depending upon the changes, the following are the types of schizophrenia commonly seen:

- (a) **Simple schizophrenia:** It is the commonest type. It mainly affects the mood of the person. He remains depressed, talks very little and is withdrawn. The motor activities are quite less.
- (b) **Hebephrenia:** In this type, the thought process is primarily derailed. Incoherence of thoughts, delusions and hallucinations are reported. The motor activities are also quite less.
- (c) **Catatonic:** In this type, the behaviour of the person is primarily abnormal. There is a wild excitement and violent and abusive behaviour. Homicidal and suicidal tendencies are very high. The person may assault someone on minor provocations. Sometimes, the person may be so violent that he needs to be restrained by force.
- (d) **Paranoid schizophrenia:** Suspicion is the primary thought process in this type. The person may be thinking that some persons are behind him and can kill him. He may have suspicion about his wife, parents, kids, friends and colleagues. It occurs more in males than in females. Delusions are very common. Usually, personality is well preserved and these people are detected as suffering from mental illness after a long time. Auditory hallucinations are quite common. He may commit crime as he thinks people are after him.
Schizophrenia is a major illness. It is quite common in the lower strata of society.

Neurosis

Neurosis is a minor mental illness. It is of following types:

1. **Anxiety Neurosis:** It is a very common variety. The person remains anxious about future events, relationships and individuals.

His pulse rate may be high, blood pressure raised, respiratory rate high and he may be sweating. He may be restless, confused and apprehensive. Treatment usually involves counselling and use of anti-anxiety drugs like diazepam. Meditation also helps a lot.

2. **Depression:** It is the reverse of anxiety. Here, a person would be aloof, sad and withdrawn. His motor activities would be quite less. He may have a low appetite and may not eat well. However, in chronic cases of depression, the person may keep on eating the whole day, while withdrawn at home and hence may gain weight. The following are the types of depression commonly seen:

- (a) **Reactive depression:** It may be due to some event or situation like the death of spouse or a near one, failure in exam, love, etc. It usually remains there for sometime. Some form of reactive depression is seen in all individuals. Usually, with counselling and use of anti-depressive drugs, most come out of it.
- (b) **Endogenous depression:** It is more serious as its aetiology is not known and develops slowly. Early morning awakening, loss of appetite and mood depression are quite common. This depression may be associated with psychosis too, where it carries a bad prognosis. Usually with anti-depressive drugs, most of the individuals recover.
- (c) **Puerperal depression:** A woman who has recently delivered may have depression commonly called 'puerperal depression'. She may even kill her infant during this time.
- (d) **Involuntional depression:** During the age group of 50–60 years, depression may set in. Delusion of hopelessness and unworthiness may be present. Due to development of hypertension, diabetes

or somatic illness, person may get into depression. Counselling, along with drugs is very useful.

- (e) **Hypochondriacal depression:** In this type of neurosis, the person usually complains of vague aches and pains and may keep on visiting many physicians but of no avail. Usually no treatment is effective.
3. **Obsessive-compulsive Neurosis:** As described earlier, obsession is a foolish thought which a person knows but cannot avoid. But once this thought turns into action, it is called compulsion and may lead to obsessive-compulsive neurosis. Common examples are repeated washing of hands to remove dirt, continuous checking of already locked premises, etc.
 4. **Hysterical Neurosis:** It is usually seen in females where there may be convulsions or stoppage of breath. Tonic and clonic convulsions are reported. It should always be differentiated from epilepsy, which it can be confused with. In hysterical neurosis, the person will never get hurt or bite the tongue, as it is seen in epilepsy. Some cause or intention can be found out in hysterical neurosis while in epilepsy usually no cause is found. Hysterical neurosis can be treated with counselling or correction of the underlying cause (Table 23.2).

Psychoses Associated with Organic Diseases or Drugs

These are of the following types:

1. **General Paralysis of the Insane:** It is due to syphilitic infection, which, when affects the brain cells, causes degeneration of neuronal cells which slowly leads to paralysis and dementia. As syphilis infection is detected early nowadays, general paralysis of the insane is not as frequently seen now

as in the past. It starts quite late after syphilis infection (10–20 years) and manifests as headache, giddiness, followed by personality changes.

2. **Psychosis due to Epilepsy:** Psychosis does develop in some cases of epilepsy, but not in all, especially in the untreated ones. There are bouts of uncontrollable mania, followed by normalcy. Hallucinations and delusions are reported. Sometimes twilight state is seen. Twilight state is seen as narrowing of fields of consciousness of short durations, followed by amnesia. Visual hallucinations are quite common. Behavioural changes are seen.
3. **Psychosis due to Head Injury:** Sometimes, as a result of head injury, there may be discontinuation or damage of neuronal cells, or there may be space occupying lesion due to haemorrhage, or direct damage. It may sometimes cause behavioural changes in the individual. This may worsen, leading to psychosis.
4. **Psychosis due to Chronic Alcoholism (Korsakoff's Psychosis):** It is characterised by loss of memory, confabulation and disorientation to time, place or person. The person may have ataxia, peripheral neuritis and encephalopathy.
5. **Psychosis due to Drugs:** Narcotics like opium, cannabis, cocaine, LSD, dhatura, etc. may cause psychosis on long-term use.

RESTRAINT OF A MENTALLY ILL PERSON

The Mental Health Act 1987 replaced the Indian Lunacy Act 1912 and introduced new terms as follows:

<i>Outdated terms</i>	<i>New terms</i>
1. Mental asylum	Psychiatric hospital or nursing home
2. Lunatic	Mentally ill person or mentally challenged person
3. Criminal lunatic	Mentally ill prisoner

The Act also defined certain terms, viz.:

1. **Medical Officer:** It means a gazetted government doctor appointed by the state government.
2. **Mentally Ill Person:** A person suffering from mental disorder other than mental retardation, and requires treatment.
3. **Mentally Ill Prisoner:** A mentally ill person ordered for detention in a psychiatric hospital, jail or other safe custody.
4. **Psychiatric Hospital or Nursing Home:** A hospital for mentally ill persons maintained by government or a private party, with facilities for out-patient treatment and registered with appropriate licensing authority.
5. **Reception Order:** It means an order for admission and detention of a mentally ill person in a psychiatric hospital or nursing home.
6. **Relative:** It includes any person related to a mentally ill person by blood, marriage or adoption.

Immediate Restraint

According to the Act, if a mentally ill person is dangerous to himself or others, or likely to injure himself, squander his property or that of others, he can legally be kept under immediate restraint in a psychiatric hospital.

Immediate restraint under the care of family or relatives may be imposed with the consent of lawful guardians, or without their consent if urgently required. This restraint is only up to the time the person is having symptoms of mental disease/danger to others.

Admission on Voluntary Basis

If a person thinks that he is mentally ill and desires to get admitted in a psychiatric hospital for treatment, he can request the medical officer-in-charge for being admitted as a voluntary patient. If

a person is minor, legal guardian can request on his behalf. If a medical officer-in-charge thinks that the person needs admission, he can admit him within 24 hours. If the admitted person wants to leave the hospital he can request the medical officer-in-charge, who can discharge him on request within 24 hours of the receipt of the request.

Admission under Special Circumstances

Any mentally ill person who does not, or is unable to express his willingness for admission as a voluntary patient, may be admitted as an in-patient in a psychiatric hospital on an application made on his behalf by a relative or a friend if the medical officer-in-charge is satisfied, that in the interest of the mentally ill person, it is necessary to do so, provided he should not be kept admitted for a period exceeding 90 days except in accordance with the provisions of the Mental Health Act, 1987. Every application under this provision shall be in a prescribed form and be accompanied by two medical certificates from two medical practitioners, of whom one shall be in government service, stating that condition of the mentally ill person is such that he should be kept under observation and treated in a psychiatric hospital. If medical certificates from two medical practitioners are not there, even then the medical officer-in-charge of a psychiatric hospital can admit the mentally ill patient after getting him medically examined by two medical practitioners working in the hospital.

Reception Order on Application

An application for a reception order may be made by:

1. Medical officer-in-charge of a psychiatric hospital.
2. Husband, wife or any other relative of the mentally ill person.

It is possible for them to do so if the medical officer-in-charge of the psychiatric hospital where the mentally ill person is admitted under temporary treatment order is satisfied that:

1. The mentally ill person is suffering from such mental disorder that he needs admission for more than 6 months, or
2. That it is necessary in the interest of the health and personal safety of the mentally ill person or for the protection of others that such person shall be detained in psychiatric hospital; he may make an application to the magistrate for reception order.

Similarly, the wife or husband or a relative can submit an application for the reception order for detention of the mentally ill person into a psychiatric hospital. On receipt of application for a reception order, the magistrate may issue reception order if he is convinced.

Reception Order on Production of Mentally Ill Person before the Magistrate

If a police officer sees a mentally ill person wandering on streets and thinks he is incapable of taking care of himself, or if he thinks that this mentally ill person is dangerous due to his mental illness, he may detain a person in his custody and produce him before a magistrate. Once produced before the magistrate, he may examine the person to assess his capacity to understand, or get him examined by a medical officer. Once this is done, the magistrate may pass a reception order for the detention of the mentally ill person in a psychiatric hospital.

Order in Case of Mentally Ill Person Cruelly Treated or Not under Proper Care and Control

If a police officer finds that a mentally ill person is cruelly treated or not under proper care and control by family members or relatives, he may report to the magistrate of the area and seek orders. The magistrate in this case, after being convinced, may pass orders requiring the family members or relatives to take care of such mentally ill person. If they do not follow orders, punishment can be awarded.

Admission and discharge of mentally ill people:

1. **Admission as In-patient after Inquisition:** If any court is holding an inquisition under Chapter VI of Mental Health Act, it may pass an order to admit a mentally ill person into a psychiatric hospital if the court is satisfied that it is in the interest of the patient.
2. **Admission and Detention of Mentally Ill Prisoner:** The court may pass an order to admit a mentally ill prisoner to a psychiatric hospital if it is convinced that he needs admission.
3. **Discharge Order by Medical Officer-in-Charge of Psychiatric Hospital:** Medical officer-in-charge of a psychiatric hospital may discharge the patient based on recommendation of two medical practitioners, one being a psychiatrist.

CIVIL RESPONSIBILITY

The mentally ill person may not be able to handle his property affairs due to mental illness. The Mental Health Act 1987 details the procedure to be adopted in such a case:

Judicial inquisition regarding alleged mentally ill person possessing property, custody of his person and management of his property:

An application may be moved before the district court by a relative, or public curator, or an advocate general for judicial inquisition into the mental condition of the person. On receipt of the application, the court issues notice to produce the person in the court. The court may order his medical examination by a psychiatrist or a psychiatric hospital. While submitting the report, the psychiatrist should mention in his report whether the person is suffering from a mental illness or not. The report should be a detailed one; it should specify the extent of mental illness and whether the person is capable of looking after his property

or not. It may be possible that the person may be mental ill, still may be able to look after his property. After holding judicial inquisition, the court may decide as follows:

1. If the court records that the person is mentally ill and is incapable of taking care of himself and of managing his property, it may order for the appointment of a guardian to take care of his person, and of a manager for management of his property.
2. When the court finds that the person is mentally ill, can take care of himself but cannot manage his property, it may issue an order for the management of his property. The manager appointed by the court has full powers to manage the property and can execute all conveyances and instruments to such effect but has no power to mortgage or sell such property without permission from the court.

CONTRACTS — RESPONSIBILITY

Under India Contract Act, if one party is of unsound mind at the time of signing contracts, the contract would be invalid in the eyes of law. Similarly, if at the time of marriage, one party by reason of unsoundness of mind, is unable to understand the nature and responsibilities of the marriage, such marriage would be declared null and void. However, unsoundness of mind developing after marriage is no ground for divorce. Minor mental illness even at the time of marriage is not a ground for divorce.

Evidence

Section 118 of the Indian Evidence Act states that a lunatic is not competent to give evidence if he cannot understand questions put to him and answer rationally. But if he is in lucid interval, he can give evidence. It is left to the judge to decide whether to give credence to evidence given by a mentally ill person or not.

Consent

Section 90 of the I.P.C. provides that consent to certain acts is not valid if it is given by a person who, due to unsoundness of mind or intoxication, is unable to understand the nature and consequence of the consent. The question of consent arises in cases of rape, marriage, operation, etc. Consent given by a mentally ill person is invalid in the eyes of law.

TESTAMENTARY CAPACITY

It is also called capacity to make will. Testamentary capacity consists of:

1. An understanding of the nature of the will.
2. A knowledge of the property to be disposed off.
3. An ability to recognise those who have moral claims in it.

If a court finds that the person who made the will, at the time of making the will, was suffering from insufficient mental capacity to understand the nature and consequences of his act, it may set aside such a will.

However, a will made by a mentally ill person during lucid interval is valid. A medical practitioner may be asked to examine whether a person is of sound mind or not, to make a valid will. The doctor should test his orientation to time, place and people, and then certify whether he is fit to make the will or not. Will made during drunken state is valid unless the person is too grossly intoxicated to understand the consequences of the act.

CRIMINAL RESPONSIBILITY OF THE INSANE

McNaughten's Rule

In 1843, one person named McNaughten, under delusion of persecution shot dead Mr. Drummond, the private secretary of Sir Robert Peel, Prime Minister of England. In fact, he wanted to kill Sir

Robert Peel but since he could not identify him properly, he shot dead Mr. Drummond by mistake. He was later arrested and sent to prison. Since he was insane and there was no English law at that time to fix criminal responsibility of an insane, a committee of 14 judges were constituted to frame law which resulted in "McNaughten's Rule" or "Legal Test" according to English law which states as follows:

That to establish a defense on the ground of insanity, it must be clearly proved that "at the time of committing the act, the accused was labouring under such a defect of reason, from disease of the mind, as not to know the nature and quality of the act he was doing, or, if he did know it, that he did not know he was doing what was wrong."

In India, Section 84 of the I.P.C. defines the legal test or criminal responsibility of the insane, as:

"Nothing is an offence which is done by a person who, at the time of doing it, by reason of unsoundness of mind, is incapable of knowing the nature of the act, or that he is doing what is either wrong or contrary to law."

Section 85 of the I.P.C. defines legal responsibility of a person under intoxication. If it is proved that a person was given intoxication without his knowledge or against his will, and due to intoxication he lost mental reasoning and then committed the crime, he will not be held responsible for it. Drunkenness caused by voluntary use of alcohol or drugs offers no excuse for committing the crime.

Loss of Self-control or Sudden and Grave Provocation

Sometimes, a person may lose self-control, or there is sudden and grave provocation, and as a result, he may commit crime. Common situation is that, if a person sees his wife teased by goons, he may lose self-control and may kill any goon. In such cases doctrine of partial responsibility is used and

the murder may be charged the under Section 304 of the I.P.C. rather than Section 302 of the I.P.C. Section 304 the of I.P.C. prescribes less sentence as compared to Section 302 of the I.P.C.

Somnambulism

This is also called 'sleep walking'. A person may move around while asleep and may commit some crime or theft, and then come back normally. He may not be aware that he has committed a crime. He will not be held responsible if it is proved that he has done this act while asleep.

Hypnosis

It is also a sleep-like stage, indeed by suggestion. But it is very difficult to convince a person in

hypnosis to commit some act which he would not do in normal circumstances. It is a wrong impression that a person may commit murder under hypnosis.

Some recent guidelines: One of the major defects in the McNaughten's Rule, which is also reflected in Section 84 of the I.P.C. is that it does not take into effect the emotional aspects relating to unsoundness of mind. So, some neurotic disorders are not given any importance. Some western countries have taken this into consideration and have formulated some guidelines. Some of them are known as:

- (a) Durham Rule (1954)
- (b) Curren's Rule (1961)
- (c) American Law Institute Test.

Miscellaneous Topics

EUTHANASIA

Euthanasia is defined as intentional killing by act or omission, of a dependent human being for his or her alleged benefit. Some medical workers divide euthanasia into two types:

1. **Active Euthanasia:** When the death is intentionally caused.
2. **Passive Euthanasia:** There are some medical actions which are often described as passive euthanasia. These acts include not commencing treatment which would have not provided relief to the patient, or withdrawing treatment that has been found to be ineffective, too burdensome, unwanted, or prescribing high doses of pain killers that can endanger life of the patient. Such actions are part of standard medical practice. Since in these actions, there is no intention to kill the person, some workers do not consider it as euthanasia. Thus, euthanasia is not there till there is intention to kill.

Reasons of Euthanasia

The following reasons are cited in favour of euthanasia:

1. **Unbearable Pain:** It is a major argument in favour of euthanasia. In terminal cases

of cancer, an individual may suffer from unbearable pain even with the use of pain killers. But with the use of new drugs and treatment, much of pain can be significantly reduced.

2. **Right to Commit Suicide:** Most workers who support the doctrine of euthanasia believe that every person should have the right to commit suicide. But, if logically thought about, in this case there is no right of suicide as the act is done by an other person and thus amounts to murder.
3. **Should a Person be Forced to Stay Alive?** An argument forwarded that whether vegetative life should be allowed to be kept on perpetual basis even against the wishes of the patient. It is cruel and inhumane. But now law is clear in such cases. Law does not ask doctors to keep death away forever in these cases.

Reasons against Euthanasia

The following reasons are cited against euthanasias:

1. **Definition of “Terminally Ill” is Not Conclusive:** The term “terminally ill” is subjective and there can be gross misuse in selection of patients. It is also found that some terminally ill patients live for years or months together.

2. **Misuse by Hospitals to Reduce Health-care Cost:** Some hospitals may have patients, on whom they have to spend a lot of money as they may be admitted in intensive care units for years, may be declared as terminally ill and may be considered for euthanasia.
3. **Importance and Value of Life would be Reduced in the Eyes of People.**

Euthanasia and Assisted Suicide

Nowadays, concept of assisted suicide has also developed. The difference between euthanasia and assisted suicide lies in who performs the last act to cause death.

In euthanasia, it is other person who performs the last act which causes death. For example, when a doctor gives a lethal injection, it is called euthanasia. But in assisted suicide, it is the person who himself performs the last act which causes death. For example, patient himself injects or drinks the poison provided by the doctor for causing death. It is also called as physician assisted suicide.

Medico-legal Significance

Euthanasia in any form is not allowed in India. It is a punishable offence under Indian Penal Code and person who does it may be prosecuted under the sections of murder, assisting suicide, etc.

In some countries, however, it is legal. Oregon, the Netherlands and Belgium are the only places in the world where laws permit euthanasia or assisted suicide. Some countries like Australia introduced it for some time but seeing its misuse, it was later repealed. Worldwide opinion is that it should not be made legal as it can be grossly abused.

TORTURE AND MEDICAL PROFESSION

Torture of human beings is as old as human race itself. In order to increase influence over others, strong human beings have always beaten the weak folk. The major reasons for torture are looting wealth, snatching womenfolk or getting desired work done like using them as labourers.

The U.N. convention against torture and other cruel, inhuman or degrading treatment or punishment has defined torture as:

“Any act by which severe pain or suffering, whether physical or mental, is intentionally inflicted on a person for such purposes as obtaining from him or third person, information or a confession, punishing him for an act he or third person has committed or is suspected to have committed, or intimidating or coercing him or a third person, or for any reason based on discrimination of any kind, when such pain or suffering is inflicted by or at the instigation of or with the consent or acquiescence of a public official or other person acting in an official capacity. It does not include pain or suffering arising from, inherent in or incidental to lawful sanctions.”

In Indian law, torture is punishable with a term extending up to 7–10 years vide Sections 330 and 331.

Methods of Torture

The methods of torture can be classified as follows:

1. **Physical Torture:** It is most common. It is caused by infliction of pain on an individual. Various methods are:
 - (a) **Beating:** The common weapons/ objects include baton, hands, feet or any other instrument. Usually, blunt weapons are used. Usual injuries are abrasions, contusion and lacerations. Head injury may be there. Sometimes, rupture of liver or hollow organs is also seen.
 - (b) **Falanga:** Severe beating on soles of the feet is called ‘falanga’. This is quite common in police beatings as due to thick skin, injuries are not much obvious.
 - (c) **Ear torture:** Twisting of external ear may be done. Beating on both ears may cause rupture of tympanic membrane and hearing loss. It is sometimes referred to as ‘telephano’.

- (d) **Finger torture:** Pencil or a small object is kept between fingers and pressed on.
- (e) **Hair torture:** Pulling of hair or dragging by hair.
- (f) **Suspension:** The victim may be suspended by legs, hands or hair and may be beaten with rods.
- (g) **Forced position:** The person may be forced to remain in forced positions for hours.
- (h) **Electric torture:** Electrodes may be kept on ears, tongue, genitalia or nipples. Small currents are passed which are very painful.
- (i) **Suffocation:** This is of two types:
 - (i) *Wet submarine:* When head is thrown into water, blood, urine or vomitus.
 - (ii) *Dry submarine:* When a plastic bag is applied on the face.
- (j) **Burning or cold torture:** When heat or cold is applied to torture.

2. **Psychological Torture:** The following are the common types of psychological tortures which are used.

Deprivation techniques: The common deprivation techniques include:

- (a) **Sensory deprivation:** Keeping him in dark, noiseless room. He may be blind-folded.
- (b) **Perceptual deprivation:** Changing place many times while blind-folded so as to lose perception of places.
- (c) **Deprivation of basic need:** Holding of food, water, clothes, communication, etc. for a long time.
- (d) **Social deprivation:** Confining them to solitary cell.
- (e) **Witness torture:** Victims are forced to see the torture of fellow-victims so as to instil fear in them.
- (f) **Threats and humiliation:** Urination on victims, extending threats of death, showing sham executions.

- (g) **Drugs:** Drugs may be given to facilitate confessions like muscle relaxants, thallium, etc.

3. **Sexual Torture:** The following are sexual torture techniques followed commonly:

- (a) **Sexual torture using instruments:**
 - (i) Penetration of vagina or anus by batons, rods, bottles or similar objects.
 - (ii) Suspension of weights on penis or scrotum.
 - (iii) Electric torture of the sexual organs.
 - (iv) Mutilation of breasts, genital organs.
- (b) **Sexual torture without the use of instruments:**
 - (i) Verbal sexual abuse and humiliation
 - (ii) Undressed in front of others
 - (iii) Rape by person of the opposite sex
 - (iv) Sexual assault by person of same sex
 - (v) Squeezing breasts
 - (vi) Forced to masturbate in front of others
 - (vii) Forced to perform sexual torture on other victims
 - (viii) Forced pregnancy
 - (ix) Being photographed in humiliating positions and situations.
- (c) **Sexual torture by using animals:**
 - (i) Rape by trained dogs, monkeys, etc.
 - (ii) Rats, mice, spiders, lizards, etc., introduced into the vagina or anus.

CUSTODIAL DEATHS

These are deaths reported in police stations, jails and detention centres. A large number of deaths are reported everywhere from all over India. There are allegations many a times that such deaths are due to police torture during interrogation. Taking a serious view of such allegations during interrogation resulting in death, National Human Rights Commission, New Delhi has prescribed

following guidelines to be observed while conducting post-mortem examination:

1. Investigation in all cases of custodial deaths is to be conducted by a magistrate as defined in Cr. P.C. Section 176.
2. The post-mortem should be conducted by a team of doctors.
3. The video recording of post-mortem is a must in all cases and videotape should be sent to National Human Rights Commission as early as possible along with the post-mortem report.
4. Report of the investigation into custody death should be sent by magistrate to National Human Rights Commission as early as possible.
5. The detailed post-mortem should be conducted and physical findings should be looked for as described in Table 24.1.
6. Viscera should be preserved in all cases preferably.
7. The police officer is instructed to follow instructions as per Table 24.2 to have assessment about since death.

Table 24.1 Instructions to be followed carefully for detention or torture cases

<i>Torture techniques</i>	<i>Physical findings</i>
Beating	
1. General	Scars, bruises, lacerations, multiple fractures at different stages of healing, especially in unusual locations, which have not been medically treated.
2. On the soles of the feet or fractures of the bones of the feet	Haemorrhage in the soft tissues of the soles of the feet and ankles. Aseptic necrosis.
3. With the palms on both ears simultaneously	Ruptured or scarred tympanic membranes. Injuries to external ear.
4. On the abdomen, while lying on a table with the upper-half of the body unsupported ("Operating table")	Bruises on the abdomen. Back injuries. Ruptured abdominal viscera.
5. To the head	Cerebral cortical atrophy. Scars, skull fractures. Bruises.
Suspension	
6. By the wrist	Bruises or scars about the wrists, joint injuries.
7. By the arms or neck	Bruises or scars at the site of binding. Prominent lividity in the lower extremities.
8. By the ankles	Bruises or scars about the ankles, joint injuries.
9. Head down, from a horizontal pole placed under the knees with the wrists bound to the "Jack"	Bruises or scars on the anterior forearms and back of the knees. Marks on the wrists and ankles.
Near suffocation	
10. Forced immersion of head, often in contaminated liquid (wet submarine)	Faecal material or other debris in the mouth, pharynx, trachea, oesophagus. Intrathoracic petechiae.
11. Tying a plastic bag over the head (dry submarine)	Intrathoracic petechiae.
Sexual abuse	
12. Sexual abuse	Sexually transmitted diseases, pregnancy, injuries to breast, external genitalia, vagina, anus, rectum.

Contd.

Contd. Table 24.1

Torture techniques	Physical findings
Forced posture	
13. Prolonged standing	Dependent oedema. Petechiae in lower extremities. Perineal or scrotal haematomas.
14. Forced straddling of a bar (Saw horse)	
Electric shock	
15. Cattle prod	Appearance of burns depends on the age of the injury. Immediately, spots, vesicles, and/or black exudates, macular scars. At several months: small, white, reddish or brown spots resembling telangiectasias. Peri-anal or rectal burns.
16. Wires connected to a source of electricity	
17. Heated metal skewer inserted into the anus	
Miscellaneous	
18. Dehydration	Vitreous humour electrolyte abnormalities. Bite marks.
19. Animal bites (Spiders, insects, rats, mice, dogs)	

Table 24.2 Additional inquest procedure

In order to help in proper assessment of 'Time Since Death', determination of temperature changes and development of rigor mortis at the time of first examination at the scene is essential. This can be attained in the present system of inquest by examining the dead body at the scene, scientifically for these two parameters either by a medical officer or trained police officer.

Essential requirement for determining temperature changes and rigor mortis.

The procedure is simple and can be learnt by any police officer if he is trained properly at the Police Training institution by a medical officer. This procedure includes:

- (i) Taking 'rectal temperature' at the first examination of the body at the scene itself while conducting the inquest. A simple rectal thermometer can be inserted in the anus of the dead body. After waiting for 3 – 5 minutes temperature should be read. The temperature so read should be mentioned in the inquest report as also the time of its recording.
- (ii) Similarly, for determining 'rigor mortis', i.e. stiffening of the muscles, the police officer should bend the limbs and see whether there is any stiffness in them. The observations about illness should be mentioned, as also the time, in the inquest report. These observations would be helpful for the doctors conducting post-mortem examination.

CLONING

Cloning is defined as creation of an organism that is an exact genetic copy of the mother. In nature, cloning is possible. Identical twins are example of natural cloning. Cloning can be done artificially through various techniques.

1. **Artificial Embryo Twinning:** This technology mimics the natural process of creating identical twins. In nature, the fertilised ovum divides into two-celled embryo which separates. Each cell continues to divide resulting in two babies inside the mother's uterus. As the two cells come from the same zygote, both individuals are genetically same. Artificial embryo twinning uses the same approach but it is done *in vitro* in a Petri dish. This involves manually separating a very early embryo into individual cells and then allowing each cell to divide and develop on its own. The resulting embryos are placed in the womb of a surrogate mother where they grow naturally. All embryos are genetically same.

2. **Somatic Cell Nuclear Transfer:** Somatic cell is the normal cell of the body other than sperm or egg. Somatic cell has two complete sets of chromosomes whereas the germ cells (sperm or egg) have only one complete set. In this somatic cell nucleus transfer technique, first a somatic cell is taken out of the body. The nucleus of the cell which contain two complete sets of chromosomes is taken out. Now, this nucleus is transferred into an egg cell from which nucleus has already been removed. The reconstructed egg cell containing the DNA from a donor cell is treated with chemicals or electric current to stimulate cell division. Once the cell division starts and embryo reaches a suitable stage, it is transferred to the uterus of a female host where it continues to develop until birth.

The first cloning according to this technique was done on sheep at Roslin Institute in 1997 and the first clone named 'Dolly' was born. It aroused worldwide interest and debate on use of cloning in human beings.

Various governments of the world raised a hue and cry over human cloning. The United Nations has now banned human cloning. The United States has banned human cloning in government-run research institutions.

Therapeutic Cloning

Also called 'embryo cloning', it is the production of human embryos for use in research. The purpose of this technique is not to clone human beings but to harvest stem cells that can be used to study human development and to treat diseases. Stem cells can be used to generate virtually any type of specialised cell in the human body. Stem cells are extracted from the egg after it has divided for 5 days. The egg at this stage of development is called a 'blastocyst'. The embryos get destroyed while

taking out stem cells. So, this process raises a lot of ethical issues. It is believed that 1 day stem cells would be used in treatment of heart disease, diabetes, Alzheimer's disease, various cancers and organ transplants.

Uses of Cloning Techniques

Recombinant DNA technology can be used along with other related technologies like gene therapy, genetic engineering of organisms and sequencing genomes. Gene therapy can be used to treat certain genetic conditions, by introducing virus vectors that carry corrected copies of faulty genes, into the cells of a host organism. This technique can be used to improve the quality of food crops or animals. Reproductive cloning can be used to repopulate endangered animals or to improve the quality of animals. Therapeutic cloning may provide humans an opportunity to produce whole organs from single cell. This can be extremely useful in diseases like Parkinson's.

Risks of Cloning

Reproductive cloning is very expensive and inefficient. Around 90 per cent of attempts fail. It is seen that in cloned animals immunity levels are down and they have higher rate of infection, carcinoma and other disorders. Some cloned animals die young. It has been reported that genomes of cloned animals are compromised and a small percentage behave abnormally. Due to programming errors, congenital abnormalities may be seen.

Human cloning: A lot of hue and cry is being made on human cloning. Now, the UN General Assembly has passed that human cloning should not be developed as it raises a lot of ethical and social issues. Governments in most of the world have already banned human cloning. But some private laboratories are still working on it.

DNA FINGERPRINTING

Structure of DNA

Deoxyribonucleic acid (DNA) is the chemical structure present in chromosomes. DNA is a double helix made of two strands of genetic material spiraled around each other. Each strand has a sequence of bases. There are four types of bases, namely, adenine, guanine, cytosine and thymine. Adenine binds only with thymine and guanine binds only with cytosine. The two strands of DNA are connected on this basis. If the following is one strand,

A–C–G–A–T–A–A–A

The complimentary strand would be as follows:

T–G–C–T–A–T–T–T

DNA is composed of sugar-phosphate backbone to which a sequence of bases is attached. A single sugar-phosphate-base unit is called a nucleotide. Specific sequence of nucleotides form distinct units called 'genes'. Genes carry our hereditary material. Each human cell contains 6×10^9 base pairs of DNA.

DNA Fingerprinting Technique

The DNA fingerprinting was first developed in 1985 by Alec Jeffreys.

Principle

DNA fingerprinting is based on the principle that, with the exception of identical twins, DNA of each person is different. The only difference between two DNAs is the order of base pairs. We can identify each person by the unique base pair sequence which he has. Since there are so many million pairs, it would be very time consuming if the whole sequence is worked out.

It has been seen that there are repeating patterns in DNA, so scientists devised methods to identify DNA in a shorter time. The sequences of repeated DNA (9–80 base pairs) vary from 1–30 and are

different in each person. These sequences are known as 'Variable Number of Tandem Repeats (VNTRs)'. Within VNTRs, there are sites where a restriction enzyme can cut DNA. The location of these sites also vary from one individual to another. The restriction enzyme cuts the DNA into fragments of different lengths. This is called 'Restriction Fragment Length Polymorphisms (RFLPs)'. On agarose gel, these DNA fragments can be separated based on their respective sizes.

DNA fingerprinting process uses the above process and DNA sequences are arranged in order of length and then tagged with radioactive probes. These emit X-rays and when the sample is photographed, it produces a pattern (bands) which is unique to each individual. Since these patterns are quite characteristic of each person, they are called fingerprint and the process is called 'DNA fingerprinting'.

Laboratory Procedure

The process of DNA fingerprinting involves following steps:

1. **Isolation of DNA:** This DNA is recovered from the tissue.
2. **Cutting, Sizing and Sorting:** Restriction enzymes are used to cut DNA at specific places. The DNA pieces are then transferred to nylon sheet by placing the sheet on the gel and soaking it overnight.
3. **Probing:** Radioactive or coloured probes are added to nylon sheet. Multiprobes are used to develop pattern, which is as unique as a fingerprint.

The final DNA fingerprint resembles barcodes used on books, grocery items.

PCR (Polymerase Chain Reaction) Technique

This technique is used to amplify the DNA sample many times. This helps in producing many copies of the sample DNA. This technique is very useful

if only a small sample of tissue is available for DNA analysis. In this, DNA from even one cell can be taken out and copied many times to get good results. The technique involves the use of primase and polymerase enzymes to produce the copies of DNA. The disadvantage of this technique is the risk of contamination while multiplying the DNA. Nowadays chemiluminescent labelling is preferred to radioactive tags.

Uses of DNA Fingerprinting

The technique is used for following purposes:

1. **Disputed Paternity:** DNA fingerprinting is now widely used in case of disputed paternity. The DNA sample of the child is compared with that of the alleged father and similarities noted. With DNA fingerprinting, paternity can be confirmed 100 per cent.
 2. **Maternity Testing:** DNA fingerprinting is used also for maternity testing especially in cases where the child is exchanged, misplaced, stolen or kidnapped from the hospital.
 3. **Use in Crime Investigation:** DNA fingerprinting was used for the first time in the identification of a rapist by Alec Jeffreys in 1980s. Now, this technique is widely used in identification of criminals by analysis of semen samples obtained from the vagina of victims of rape, blood stain or hair found at the scene of crime, or on clothes.
 4. **Diagnosis of Inherited Disorders:** DNA fingerprinting is used in the diagnosis of inherited disorders in prenatal and newborn babies. Such diseases are cystic fibrosis, haemophilia, Huntington's disease, familial Alzheimer's disease, sickle cell anaemia, and thalassaemia.
 5. **Developing Treatment of Genetic Disorders:** Locating genes of genetic disorders on chromosomes and studying them may help in future in developing treatment of genetic disorders.
6. **Migration of Population:** DNA fingerprinting can be used in determining how the races migrated from one region to another by comparing the DNA fingerprints. It will give us a look into the history of settlement of races.

Collection of Samples for DNA Fingerprinting

The following samples can be used for DNA fingerprinting:

1. **Blood:** It is the best sample, and is collected by venous or capillary puncture. 10 ml of blood can be collected from peripheral vein in a bottle containing anti-coagulant EDTA. Nowadays, special bags are available which are vacuum based. Quantity of blood that needs to be collected may vary from 1 to 2 ml. The blood should be transported to laboratory at -20°C under dry ice.
2. **Buccal Epithelial Cells:** The cells are collected from the inside of the subject's mouth using sterile dry swabs. Two samples are taken, one from each cheek. The swabs are allowed to dry at room temperature. Once these dry, they should be packed in separate bottles only then, otherwise bacteria present in saliva will degrade DNA.
3. **Hair Follicles:** 10–15 hairs with roots should be pulled from the subject and sealed in a sterile bottle.

Precautions: The buccal swabs should be taken only after the subject has rinsed his/her mouth with plain water to remove food particles.

4. Samples from Dead Bodies

- (a) **Samples from well preserved dead bodies**
 - (i) *Post-mortem blood:* 10 ml should be drawn in a tube from heart in a bottle containing EDTA as an anti-coagulant.

- (ii) *Skeletal muscle*: Two portions of skeletal muscle of size about 2 cm and weight 10 gm should be taken from the most well preserved area. Cardiac muscle can also be preserved.
 - (iii) *Teeth*: Four teeth, preferably molars, can be preserved.
- (b) **Samples from charred or semi-charred bodies**: Where charring is not complete, portions of skeletal muscle from deep regions can be preserved. Semi-solid blood that remains in cardiac cavity can also be preserved. If charring is complete, it may not be possible to detect DNA.
- (c) **Samples from decomposed or skeletonised bodies**: Decomposed tissue can be preserved along with long bones like femur, humerus or sternum, which contain a lot of bone marrow. Teeth, preferably molars, should be preserved.

Precautions: No preservative should be used for any sample except blood. All the samples should be preserved in clean and sterile containers with proper labelling. The biggest threat is contamination with other DNA.

Samples from Crime Scene

Seminal stains, salivary stains, debris below fingernails and hair can be taken from the crime scene and preserved in a similar fashion. The samples should be kept in dry ice at -20°C and sent to DNA Lab at the earliest.

EMBALMING

Definition

Embalming is defined as the study and science of treating a dead body to achieve antiseptic condition,

a life-like post-mortem appearance and preservation.

History

Embalming originated in ancient Egypt in about 3200 B.C. and continued till 650 A.D. Egyptians believed that the soul has to pass through several life cycles, therefore it is necessary to preserve the body so that the soul can return to it.

Present Use

In modern times the aim of embalming is to preserve dead bodies for dissection in medical colleges, transportation of the body to a long distance, or waiting for the relatives to come to collect the body.

Principle

By procedure of embalming, the proteins of the body are coagulated, tissues and fixed organs are bleached and hardened, and blood is converted into brownish mass as a result of the preservatives used.

Preservatives Used

The most common preservative is formaldehyde. It has a very strong, pungent smell and is an irritant. In high concentration, it dehydrates the tissues and restricts permeability into deeper tissues. It produces excessive hardening. Another preservative used along with formaldehyde is methyl alcohol, which is volatile, inflammable and stabilises the formaldehyde. Sometimes phenol is also used. Buffers, wetting agents and anticoagulants are also used along with preservatives. To produce a cosmetic effect simulating natural colour of tissues, dyes like eosin, erythrosine acid, fuchsin and Toluidine red are used. Water is used as a

vehicle to push the ingredients into the body. Perfuming agents are also used to mask the unpleasant odour.

Methods of Embalming

The following are the techniques of embalming dead bodies:

1. **Arterial Embalming:** Fluid is injected through arch of aorta so as to reach all areas of the body through arteries. It can be injected by (a) gravity method which is very time consuming or (b) electric pump method through air pressure. About 10 litres of fluid is injected.
2. **Cavity Embalming:** After arterial injection, the thoracic, abdominal and pelvic cavities are injected with about 2 litres of fluid to detoxicate those materials which cannot be aspirated.
3. **Hypodermic Embalming:** Subcutaneous injection of fluids are given by hypodermic syringe with a wide bore needle into isolated fragments of the body and limbs.
4. **Surface Embalming:** Packs of cotton soaked in preservative fluid are applied to raw skin, especially in burnt skin or bed sores.

Medico-legal Importance

The medico-legal importance of embalming is as follows:

1. To carry the dead body in an aeroplane, ship or train, embalming is mandatory as per law. Certificate of embalming is required from a doctor.
2. Embalming alters the appearance of normal tissues and organs, so it is difficult to interpret injuries or disease.

3. Embalming destroys certain poisons like alcohol and cyanide present in the body. So, toxicological analysis of embalmed body may not be accurate.

WORKMEN'S COMPENSATION ACT, 1923

The purpose of this act is to provide compensation to workers in the event of any injury, disability or disease occurring when under employment. This Act is called 'Workmen's Compensation Act, 1923'. It extends to the whole of India. The salient features of this Act are as follows:

Definitions

1. "Commissioner" means a commissioner for workmen compensation as appointed by the government.
2. "Compensation" means compensation as provided by this Act.
3. "Dependent" means closest relative of the deceased person including wife, children, parents or other relations as provided under.
4. "Employer" includes any body of persons or any managing agent of the employer.
5. "Partial disablement" means where the disablement is temporary in nature, and it reduces the earning capacity of the worker in any employment in which he was engaged at the time of the accident.
6. "Total disablement" means such disablement, whether temporary or permanent in nature, incapacitates a workman for all works, which he was capable of performing at the time of the accident.
7. "Workman" means any person who is a railway servant or employed in as provided under Schedule II.

Employer's Liability for Compensation

If personal injury is caused to a workman by accident arising out of and in course of his employment, his employer shall be liable to pay compensation. This compensation is not payable if partial disablement is for less than 30 days; or the accident has been caused by workman when he is under the influence of alcohol, drugs or wilful disregard to safety norms. Compensation is payable if workman contracts some occupational disease due to working in that atmosphere and peculiar to that employment. List of occupational diseases is given in Table 24.3.

Amount of Compensation

The amount of compensation is as follows:

1. **Where Death Results from Injury:** An amount equal to forty per cent of monthly wages of the deceased workman multiplied by relevant factor or an amount of Rs. 20,000/, whichever is more.
2. **Where Permanent Total Disablement Results from Injury:** An amount equal to fifty per cent of monthly wages multiplied by relevant factor or an amount of Rs. 24,000/, whichever is more.

Relevant factor: Relevant factor, as mentioned above, means the factor specified in Schedule IV specifying the number of years which are same as completed years of the age of workman on his last birthday, immediately preceding the date on which compensation fell due (Table 24.4).

3. **Where Permanent Partial Disablement Results from Injury:** In case of an injury

specified in Part II of Schedule I, such percentage of compensation which would be payable in case of permanent total disablement as is specified therein as being the percentage of the loss of earning capacity due to injury. While in the case of injury not specified in Schedule I, such percentage of the compensation payable in the case of permanent total disablement as is proportionate to the loss of earning capacity as assessed by the doctor who examines such a case (Table 24.5).

4. Where temporary disablement (total or partial) results from injury, half monthly payment of the sum equivalent to 25 per cent of the monthly wages.

Medical Examination

Once a workman suffers from an accident, he should give notice to the employer. The employer can get him medically examined free of cost by a qualified medical practitioner to assess the injury caused.

Role of a Commissioner

All cases under the Workmen's Compensation Act are settled by a commissioner appointed by the government. Any worker can approach him for the award of compensation in the event of an injury. If employer or worker is not satisfied with the compensation, he can approach the high court by filing appeal against the order. Detailed knowledge of the Workmen's Compensation Act can be obtained by referring to this Act in detail.

Table 24.3 List of occupational diseases**[Schedule III]¹ (See Section 3)**

<i>S. No.</i>	<i>Occupational diseases</i>	<i>Employment</i>
Part A		
1.	Infectious and parasitic diseases contracted in an occupation where there is a particular risk of contamination.	(a) All work involving exposure to health or laboratory work. (b) All work involving exposure to veterinary work. (c) Work relating to handling animals, animal carcasses, part of such carcasses, or merchandise which may have been contaminated by animals or animal carcasses. (d) Other work carrying a particular risk of contamination.
2.	Diseases caused by work in compressed air.	All work involving exposure to the risk concerned.
3.	Diseases caused by lead or its toxic compounds.	All work involving exposure to the risk concerned.
4.	Poisoning by nitrous fumes.	All work involving exposure to the risk concerned.
5.	Poisoning by organophosphorous compounds.	All work involving exposure to the risk concerned.
Part B		
1.	Diseases caused by phosphorus or its toxic compounds.	All work involving exposure to the risk concerned.
2.	Diseases caused by mercury or its toxic compounds.	All work involving exposure to the risk concerned.
3.	Diseases caused by benzene or its toxic homologues.	All work involving exposure to the risk concerned.
4.	Diseases caused by nitro and amido toxic derivatives of benzene or its homologues.	All work involving exposure to the risk of concerned.
5.	Diseases caused by chromium or its toxic compounds.	All work involving exposure to the risk concerned.
6.	Diseases caused by arsenic or its toxic compounds.	All work involving exposure to the risk concerned.
7.	Diseases caused by radioactive substances and ionising radiations.	All work involving exposure to the action of radioactive substances or ionising radiations.
8.	Primary epitheliomatous cancer of the skin caused by tar, pitch, bitumen, mineral oil, anthracene, or the compounds, products or residues of these substances.	All work involving exposure to the risk concerned.
9.	Diseases caused by the toxic halogen derivatives of hydrocarbons (of the aliphatic and aromatic series).	All work involving exposure to the risk concerned.
10.	Diseases caused by carbon disulphide.	All work involving exposure to the risk concerned.
11.	Occupational cataract due to infra-red radiations.	All work involving exposure to the risk concerned.
12.	Diseases caused by manganese or its toxic compounds.	All work involving exposure to the risk concerned.

Contd.

Contd. Table 24.3

<i>S. No.</i>	<i>Occupational diseases</i>	<i>Employment</i>
13.	Skin diseases caused by physical, chemical or biological agents not included in other items.	All work involving exposure to the risk concerned.
14.	Hearing impairment caused by noise.	All work involving exposure to the risk concerned.
15.	Poisoning by dinitrophenol or a homologue or by substituted dinitrophenol or by the salts of such substances.	All work involving exposure to the risk concerned.
16.	Disease caused by beryllium or its toxic compounds.	All work involving exposure to the risk concerned.
17.	Diseases caused by cadmium or its toxic compounds.	All work involving exposure to the risk concerned.
18.	Occupational asthma caused by recognised sensitising agents inherent to the work process.	All work involving exposure to the risk concerned.
19.	Diseases caused by fluorine or its toxic compounds.	All work involving exposure to the risk concerned.
20.	Diseases caused by nitroglycerine or other nitro acid esters.	All work involving exposure to the risk concerned.
21.	Diseases caused by alcohols and ketones.	All work involving exposure to the risk concerned.
22.	Diseases caused by asphyxiants; carbon monoxide, and its toxic derivatives, hydrogen sulfide.	All work involving exposure to the risk concerned.
23.	Lung cancer and mesotheliomas caused by asbestos.	All work involving exposure to the risk concerned.
24.	Primary neoplasm of the epithelial lining of the urinary bladder or the kidney or the ureter.	All work involving exposure to the risk concerned.

Part C

1.	Pneumoconioses caused by sclerogenic mineral dust (silicosis, anthrosilicosis, asbestosis) and silico-tuberculosis provided that silicosis is an essential factor in causing the resultant incapacity.	All work involving exposure to the risk concerned.
2.	Bagassosis.	All work involving exposure to the risk concerned.
3.	Bronchopulmonary diseases caused by cotton, flax hemp and sisal dust (Byssinosis).	All work involving exposure to the risk concerned.
4.	Extrinsic allergic alveolitis caused by inhalation of organic dusts.	All work involving exposure to the risk concerned.
5.	Bronchopulmonary diseases caused by hard metals.	All work involving exposure to the risk concerned.

Table 24.4 Factors for working out lump sum equivalent of compensation amount in case of permanent disablement and death**[Schedule IV]¹ (See Section 4)**

<i>Completed years of age on the last birthday of the workman immediately preceding the date on which the compensation fell due</i>		<i>Factors</i>	<i>Completed years of age on the last birthday of the workman immediately preceding the date on which the compensation fell due</i>		<i>Factors</i>
Not more than	16	228.54	41		181.37
	17	227.49	42		178.49
	18	226.38	43		175.54
	19	225.22	44		172.52
	20	224.00	45		169.44
	21	222.71	46		166.29
	22	221.37	47		163.07
	23	219.95	48		159.80
	24	218.47	49		156.47
	25	216.91	50		153.09
	26	215.28	51		149.67
	27	213.57	52		146.20
	28	211.79	53		142.68
	29	209.92	54		139.13
	30	207.98	55		135.56
	31	205.95	56		131.95
	32	203.85	57		128.33
	33	201.66	58		124.70
	34	199.40	59		121.05
	35	197.06	60		117.41
	36	294.64	61		113.77
	37	192.14	62		110.14
	38	189.56	63		106.52
	39	186.90	64		102.93
	40	184.17	65 or more		99.37

Table 24.5 Percentage of loss of earning capacity**4[Schedule]¹
5[See Section 2(1) and (4)]**

<i>S. No.</i>	<i>Description of injury</i>	<i>Percentage of loss of earning capacity</i>
Part I⁶	List of injuries deemed to result in permanent total disablement	
1.	Loss of both hands or amputation at higher sites	100
2.	Loss of both hands and a foot	100
3.	Double amputation through leg or thigh, or amputation through leg or thigh on one side and loss of other foot	100
4.	Loss of sight to such an extent as to render the claimant unable to perform any work for which eyesight is essential	100

Contd.

Contd. Table 24.5

S. No.	Description of injury	Percentage of loss of earning capacity
5.	Very severe facial disfigurement	100
6.	Absolute deafness	100
Part II	List of injuries deemed to result in permanent partial disablement <i>Amputation cases—upper limbs (either arm)</i>	
1.	Amputation through shoulder joint	90
2.	Amputation below shoulder with stump less than 8" from tip of acromion	80
3.	Amputation from 8" tip of acromion to less than 4.5" below tip of olecranon	70
4.	Loss of a hand or of the thumb and fingers of one hand and amputation 4½" below tip of olecranon	60
5.	Loss of thumb	30
6.	Loss of thumb and its metacarpal bone	40
7.	Loss of four fingers of one hand	50
8.	Loss of three fingers of one hand	30
9.	Loss of two fingers of one hand	20
10.	Loss of terminal phalanx of thumb	20
	<i>Amputation cases—lower limbs</i>	
11.	Amputation of both feet resulting in end bearing stumps	90
12.	Amputation through both feet proximal to the metatarsophalangeal joint	80
13.	Loss of all toes of both feet through the metatarsophalangeal joint	40
14.	Loss of all toes of both feet proximal to the proximal interphalangeal joint	30
15.	Loss of all toes of both feet distal to the proximal interphalangeal joint	20
16.	Amputation at hip	90
17.	Amputation below hip with stump not exceeding 5" in length measured from tip of great trochanter	80
18.	Amputation below hip with stump not exceeding 5" in length measured from tip of great trochanter but not beyond middle thigh	70
19.	Amputation below middle thigh to 3.5" below knee	60
20.	Amputation below knee with stump exceeding 3.5" but not exceeding 5"	50
21.	Amputation below knee with stump exceeding 5"	40
22.	Amputation of one foot resulting in end bearing	30
23.	Amputation through one foot proximal to the metatarsophalangeal joint	30
24.	Loss of all toes of one foot through the metatarsophalangeal joint	20
	<i>Other injuries</i>	
25.	Loss of one eye, without complications, the other being normal	40
26.	Loss of vision of one eye, without complications or disfigurement of eyeball, the other being normal	30
	<i>Loss of:</i>	
	<i>Fingers of right or left hand</i>	
	<i>Index finger</i>	
27.	Whole	14
28.	Two phalanges	11
29.	One phalanx	9
30.	Guillotine amputation of tip without loss of bone	5

Contd.

Contd. Table 24.5

S. No.	Description of injury	Percentage of loss of earning capacity
<i>Middle finger</i>		
31.	Whole	12
32.	Two phalanges	9
31.	Whole	12
32.	Two phalanges	9
33.	One phalanx	7
34.	Guillotine amputation of tip without loss of bone	4
<i>Ring or little finger</i>		
35.	Whole	7
36.	Two phalanges	6
37.	One phalanx	5
38.	Guillotine amputation of tip without loss of bone	2
<i>B. Toes of right or left foot</i>		
<i>Great toe</i>		
39.	Through metatarsophalangeal joint	14
40.	Part, with some loss of bone	3
<i>Any other toe</i>		
41.	Through metatarsophalangeal joint	3
42.	Part, with some loss of bone	1
<i>Two toes of one foot, excluding great toe</i>		
43.	Through metatarsophalangeal joint	5
44.	Part, with some loss of bone	2
<i>Three toes of one foot, excluding great toe</i>		
45.	Through metatarsophalangeal joint	6
46.	Part, with some loss of bone	3
<i>Four toes of one foot, excluding great toe</i>		
47.	Through metatarsophalangeal joint	9
48.	Part, with some loss of bone	3

Note: Complete and permanent loss of the use of any limb or member referred to in this schedule shall be deemed to be equivalent of the loss of that limb or member.

CHAPTER 25

Law in Relation to Medical Practice: Part I

Doctor-patient relationship is the cornerstone of medical practice. It is a very sacred one as it has evolved through the ages. In the early ages, a doctor was considered equivalent to God and whatever the doctor said was considered by patients as law and was undisputable. At that time, most medical practitioners never charged anything from the patients but lived on the voluntary offerings made by them. This relationship continued for ages. In modern times, when doctors started charging for their professional advice, it transformed the doctor-patient relationship. Now, the patients have started evaluating the professional advice with the money they pay.

This evaluation has given new meaning to the relationship and has made it more responsive on behalf of medical practitioners. As of today, the doctor-patient relationship is a contractual one under the Contract Act and it establishes immediately once the patient steps into the clinic of the doctor and he agrees to treat him. As we understand that the relationship is contractual and mutually binding, we have to understand the rights and obligations of the doctor and the patient.

RIGHTS OF THE PATIENT

Right to Choose a Doctor of His Own Choice

It is the fundamental right of the patient to choose a doctor of his own choice. No patient can be forced under law, to visit a particular doctor for advice.

Although sometimes, the patient may have to sacrifice his choice as in the following cases:

1. If a doctor of his choice is not available at that particular time.
2. If the patient is covered by medical insurance or deriving health benefits from some organisations like the E.S.I., C.G.H.S., etc., he may be asked to go to the doctor on the panel of these organisations, otherwise he will not be reimbursed the cost of professional advice/treatment. If the patient is ready to forego the charges he can visit the doctor of his own choice.
3. For recruitment purposes, he may be asked to report to a selected board of doctors.
4. The court may direct a litigant to get his medical condition evaluated by a selected doctor but cannot force the litigant to receive treatment from him.
5. In case of unconsciousness, any doctor can give him treatment with permission taken from a relative/attendant or without permission if no one is with the patient.

Right to Information

The patient has the absolute right to know about the disease he is suffering from, how the diagnosis is going to be made, how the treatment is planned, what type of anaesthesia is to be given, what are the choices of treatment available, what are the risks involved if there is any alternative treatment

available, and lastly, the prognosis and the cost of the treatment.

Right to Privacy

The patient enjoys the same rights to privacy as are available to other people. While examining, the doctor should note that no outsider/undesirable persons are present during the examination/treatment. Special care should be taken while examining female patients. It is better that examination of female patients may be done in the presence of a nurse or the attendant of the patient.

Right to Confidentiality

All the information arising out of treatment of the patient should be kept confidential and should not be made public without the written consent of the patient.

Right to Pictures/Video Recording

Any pictures or video recording of the patient while receiving treatment should be taken only after written permission of the patient. Even after permission, the identity of the individual should be kept a secret and should not be revealed by pictures or text accompanying them.

Right to Change Doctor at Any Stage of Treatment

The patient can change his doctor at any stage of the treatment without giving any reason. But when he has started taking advice from the second doctor, the first doctor would not be responsible for any negligence suffered by the patient from the moment he had terminated the doctor-patient relationship with the first one.

Right to Grievance Redressal

The patient has the fundamental right to approach the court of law or a consumer forum for any grievance against the doctor. He has also the right to approach the medical council against ethical malpractice of the doctor.

DUTIES OF THE PATIENT

These are:

1. He should cooperate with the doctor by giving information about the disease process, family and personal history.
2. He should have faith in the doctor chosen by him.
3. He should regularly follow the advice of the doctor.
4. If he wishes to take a second consultation, he should inform the first doctor.
5. He should not contribute to medical negligence.
6. He should promptly pay the doctor his fee.

RIGHTS OF THE DOCTOR

Right to Choose Patients of His Choice

All the medical practitioners have the fundamental right to choose their patients. If somebody has started practice, it does not mean that he has to see all the patients coming to him for advice. He can make a selection out of them. But all medical practitioners cannot have their choice of patients all the time. In the following situations all doctors are bound to treat all.

Emergency: In life-threatening situations, the doctor should not refuse treatment citing his right to choose the patient. He should offer emergency medical treatment and once the patient has been stabilised he can ask the patient to go to a doctor of his choice.

In mass disasters/road traffic accidents: Emergency treatment should always be provided in cases of disasters and road accidents. If the doctor is not following these, action can be taken against him by the medical council for violating the code of ethics.

Right to Charge Professional Fee

Every doctor has the legal right to charge a professional fee. It is better that he should display

it in his waiting room so that the patient does not complain of not noticing it. Although the doctor has the right of determining his own professional fee, it is desirable that it should not be so high that he is out of reach for professional advice for the majority of the population.

Right of Termination of Advice

As the patient has the right to change the doctor so the doctor also has the right to terminate his services to the patient if he notices that the patient is not following his advice properly or is also taking treatment from other doctors without his permission. But even in such cases, the doctor should not abandon his patient. He should give advance notice to the patient that he is terminating his professional services due to certain reasons and the patient should search for another doctor. Till the other doctor has taken charge of the patient, he should continue to provide his services without fail.

DUTIES OF THE DOCTOR

When a doctor develops a relationship with the patient, he comes under the following obligations:

1. He is under the obligation to apply a reasonable degree of skill and care.
2. He is liable for any injury to the patient resulting from failure to exercise reasonable skill and care.
3. He should not accept more patients than he can handle properly.
4. He should charge reasonably as agreed upon.

CONSENT

Consent is a legal requirement for examination and treatment of the patient. The nature of the consent varies according to the needs. Failure to obtain consent can make physician liable for prosecution and damages. Consent may be implied or express.

Implied Consent

When a patient has come to a physician for treatment and has waited for his turn to come and paid the professional fee, he has supposedly consented for the treatment. This is called implied consent. But this consent is valid only for physical examination and not for any procedure. It may be noted that this consent is only for inspection, palpation, percussion and auscultation. Even in these, physician should request the patient's permission to access the body. For vaginal and rectal examination express permission is needed.

Express Consent

Anything other than implied consent described above is express consent. It may be oral or written consent. For minor examination like vaginal or rectal examination an oral consent is sufficient but for procedure, consent should be obtained in writing. The oral consent should be obtained in the presence of a disinterested person like nurse. Although oral consent has the same validity as a written consent in the eyes of the law it is easier to document written consent and avoid future litigations.

Written consent is a must for all major diagnostic and surgical interventions. It should be specific for a particular procedure. It should not be a "blanket consent." It has been seen that in many nursing homes or small hospitals, a blanket consent in the following manner is taken from the patient. "I hereby authorise staff of this hospital to perform any surgical or anaesthetic procedure on me."

This sort of blanket consent is invalid in the eyes of law. Nowadays, the latest concept of informed consent is followed.

Informed Consent

Nowadays, more and more patients are getting aware of their civil rights and assert the "right to

know.” Informed consent deals with patients’ rights and obligations. Patient has the right to know what disease he is suffering from and how the diagnosis and treatment are planned. He has the right to know the potential risks involved and if any alternative treatment is also available or not. Patient has also the right to know about the approximate cost of the treatment.

The physician should explain all these to the patient or his attendant in detail in the patient’s language. The signature of the patient or relative should be obtained in presence of a disinterested third party like an attendant of the patient or a nurse. Finally, it should be counter-signed by the physician in charge of the patient. A model informed consent form is attached and it is recommended to be followed. This form is based on the consent form used in All India Institute of Medical Sciences (AIIMS), New Delhi.

From Whom is the Consent to be Obtained

Consent should be obtained from conscious mentally sound patient. If a person is unconscious, the consent can be obtained from a near relative/friend. If no relative/friend is available then consent need not be taken and the physician should proceed in good faith. For minors, consent can be obtained from parents/guardians or near relatives. A child below 12 years cannot give consent. A child above 12 years but below 18 years can give consent only for medical examination but not for any procedure. A consent for mentally defective patient can be given by a near relative/friend.

When is Consent not Required

In following conditions, consent of the patient is not required as per law:

1. When a person is brought for medical examination by police, like in cases of alcoholic intoxication, sexual assault, etc., no consent of the patient is required for

medical examination but no treatment can be enforced without consent of the patient.

2. In case of an arrested person brought by police to take blood sample/sample of hair or anything required for evidence, consent of the person detained is not necessary and even reasonable force can be applied to obtain the sample.
3. Medical examination can be carried out without permission of the patient if he has been directed by the court. But in case of a rape victim, the genitalia examination cannot be carried out without the permission of the patient in writing.
4. Consent is not needed for medical examination if it is statutory like in armed forces, immigration, etc.

Consent from Spouse to be Taken

It is advisable to take consent of the spouse in the following procedures although in many cases it may not be legally necessary:

1. Termination of pregnancy.
2. Sterilisation.
3. Artificial insemination.
4. Donation of sperms.
5. Any operation that can have a bearing on the sexual rights of the spouse.

When is Consent not Valid

In the following cases, consent given is not valid:

1. Consent given by a mentally unsound patient.
2. Blanket consent.
3. Consent obtained for a criminal activity like criminal abortion, euthanasia or any mutilating operation.
4. When consent is not voluntary and free.
5. When consent is obtained by force, fear or fraud.

MODEL INFORMED CONSENT FORM

Registration No. _____ NAME _____ SEX: _____ AGE: _____ SON/DAUGHTER/WIFE OF _____ ADDRESS _____ _____
--

Authorisation for Medical Treatment, Administration of Anaesthesia and performance of Surgical Operation and/or Diagnostic/Therapeutic Procedure.

1. I hereby authorise
(name of hospital) and staff to perform upon.....
 the following medical treatment, surgical operation and/or diagnostic/therapeutic procedures
- 2 It has been explained to me that, during the course of the operation/procedure, unforeseen conditions may be revealed or encountered which necessitate surgical or other emergency procedures in addition to or different from those contemplated at the time of initial diagnosis. I, therefore, further authorise the above designated staff to perform such additional surgical or other procedures as they deem necessary or desirable.
3. I consent to the administration of anaesthesia and to use such anaesthetics as may be deemed necessary or desirable, except to the following exceptions:

 (Indicate exception or 'None')
4. I state that I am/am not suffering from Hypertension/Diabetes/Bleeding disorders/Heart diseases or.....
5. I also state that I am not suffering from any known allergies or drug reactions.

6. To the best of my knowledge, I further consent to the administration of such drugs, infusions, plasma or blood transfusions or any other treatment or procedures deemed necessary.
7. The nature and purpose of the operation and/or procedures, the necessity thereof, the possible alternative methods, treatment, prognosis, the risks involved and the possibility of complications in the investigative procedures/investigations and treatment of my condition/diagnosis have been fully explained to me and I understand the same.
8. I have been given an opportunity to ask all/ any questions and I have also been given option to ask for any second opinion.
9. I acknowledge that no guarantee and promises have been made to me concerning the result of any procedure/treatment.
10. I consent to the photographing or televising of the operations or procedures to be performed, including appropriate portions of my body, for medical, scientific or educational purposes, provided my identity is not revealed by the pictures or by descriptive texts accompanying them.
11. For the purpose of advancing medical education, I hereby give consent to the admittance of observers to the operating room.
12. I also give consent to the disposal by hospital authorities of any deceased tissues

or parts thereof necessary to be removed during the course of operative procedure/ treatment.

I CERTIFY THAT THE STATEMENTS MADE IN THE ABOVE CONSENT LETTER HAVE BEEN READ OVER AND EXPLAINED TO ME IN MY MOTHER TONGUE AND I HAVE FULLY UNDERSTOOD THE IMPLICATIONS OF THE ABOVE CONSENT AND FURTHER SUBMIT THAT STATEMENTS THEREIN REFERRED TO WERE FILLED IN AND ANY INAPPLICABLE PARAGRAPHS STRICKEN OFF BEFORE I SIGNED/PUT MY THUMB IMPRESSION.

Signature of the patient/
Thumb impression:
Name:

Date:

Signature, name and address of the witnesses:

- 1. 2.

WHEN PATIENT IS A MINOR OR UNABLE TO AFFIX SIGNATURE DUE TO MENTAL OR PHYSICAL DISABILITY.

Signature/thumb impression of natural guardian/guardian: Name and relationship with patient:

Signature:

Name:

Address of witnesses:

- 1. 2.

I CONFIRM THAT I HAVE EXPLAINED THE NATURE AND EFFECTS OF THE OPERATION/ TREATMENT TO THE PERSON WHO HAS SIGNED THE ABOVE CONSENT FORM.

Signature of Doctor-in-charge

Name:

Date:

Designation:

MEDICAL ETHICS

Medical ethics may be defined as a code of conduct accepted voluntarily by medical practitioners within the profession. Legally, they are not enforceable by law but are defended by the State Medical Council.

Medical ethics have evolved through the centuries. Some of the ethics have evolved into present law, so both the terms, medical ethics and medical law, are synonymous.

Code of Medical Ethics

The oldest code of medical ethics is the Hippocratic Oath. Even after twenty-five centuries, its basic principles are still valid and are followed.

The Charak and the Hippocratic Oath

In India, Charak was the first physician to start the practice of oath many centuries ago. In All India Institute of Medical Sciences, New Delhi, young doctors take the Charak Oath before starting medical practice and it is administered during the convocation when the degree is awarded.

OATH

“Not for the self,
Not for the fulfillment of any worldly material
desire or gain,
But solely for the good of suffering humanity, I
will treat my patient and excel all”.

— Charak

The Hippocratic Oath

‘I swear by Apollo the physician, by Aesculapius, Hygieia and Panacea, and I take to witness all the Gods, all the Goddesses, to keep according to my ability and my judgement the following Oath:

“To consider dear to me as my parents him who taught me this art; to live in common with him and if necessary to share my goods with him; to look upon his children as my own brothers, to

teach them this art if they so desire without fee or written promise; to impart to my sons and the sons of the master who taught me and the disciples who have enrolled themselves and have agreed to the rules of the profession, but to these alone, the precepts and the instruction. I will prescribe regimen for the good of my patients according to my ability and my judgement and never do harm to anyone. To please no one will I prescribe a deadly drug, nor give advice which may cause his death. Nor, will I give a woman a pessary to procure abortion. But I will preserve the purity of my life and my art. I will not cut for stone, even for patients in whom the disease is manifest; I will leave this operation to be performed by practitioners (specialists in this art). In every house where I come I will enter only for the good of my patients, keeping myself far from all intentional ill-doing and all seduction, and especially from the pleasures of love with women or with men, be they free or slaves. All that may come to my knowledge in the exercise of my profession or outside of any profession or in daily commerce with men, which ought not to be spread abroad. I will keep secret and will never reveal. If I keep this oath faithfully, may I enjoy my life and practise my art, respected by all men and in all times; but if I swerve from it or violate it, may the reverse be my lot.”

During the World War II, gross violation of medical ethics was reported. Keeping this in view, the World Medical Association was formed at the instigation of the British Medical Association. It restarted the Hippocratic Oath in a new manner and was known as the Declaration of Geneva.

Declaration of Geneva

(As amended at Sydney, 1968)

At the time of being admitted a member of the medical profession:

I will solemnly pledge myself to consecrate my life to the service of humanity;

I will give to my teachers the respect and gratitude which is their due;
I will practise my profession with conscience and dignity;
The health of my patient will be my first consideration;
I will respect the secrets which are confided in me, even after the patient has died;
I will maintain by all the means in my power the honour and the noble traditions of the medical profession;
My colleagues will be my brothers; I will not permit considerations of religion, nationality, race, party politics or social standing to intervene between my duty and my patient;
I will maintain the utmost respect for human life from the time of conception; even under threat, I will not use my medical knowledge contrary to the laws of humanity.
I make these promises solemnly, freely and upon my honour.

Keeping in view the Declaration of Geneva, an International Code of Medical Ethics was evolved as under:

International Code of Medical Ethics

Duties of doctors in general:

A doctor must always maintain the highest standards of professional conduct.

A doctor must practise his profession uninfluenced by motives of profit.

The following practices are deemed unethical:

- Any self-advertisement except such as is expressly authorised by the national code of medical ethics.
- Collaboration in any form of medical service in which the doctor does not have professional independence.
- Receiving any money in connection with services rendered to a patient other than a proper professional fee, even with the knowledge of the patient.

Any act or advice which could weaken physical or mental resistance of a human being may be used only in his interest.

A doctor is advised to use great caution in divulging discoveries or new techniques of treatment.

A doctor should certify or testify only to that which he has personally verified.

Duties of Doctors to the Sick

A doctor must always bear in mind the obligation of preserving human life.

A doctor owes to his patient complete loyalty and all the resources of his science.

Whenever an examination or treatment is beyond his capacity he should summon another doctor who has the necessary ability.

A doctor shall preserve absolute secrecy on all he knows about his patients because of the confidence they have entrusted in him.

A doctor must give emergency care as a humanitarian duty unless he is assured that others are willing and will be able to give such care.

Duties of Doctors to Each Other

A doctor ought to behave to his colleagues as he would have them behave to him. A doctor must not entice patients from his colleagues.

A doctor must observe the principles of ‘The Declaration of Geneva’ approved by the World Medical Association. During Second World War, unethical human experimentation was carried out extensively. World Medical Association in 1964 drew a code of conduct for doctors intending to start experimental treatment. This code is known as Declaration of Helsinki.

Declaration of Helsinki

(Revised 1975)

Recommendations guiding medical doctors in biomedical research involving human subjects.

Introduction

It is the mission of the medical doctor to safeguard the health of the people. His or her knowledge and conscience are dedicated to the fulfillment of this mission. The Declaration of Geneva of the World Medical Association binds the doctor with the words: "The health of my patient will be my first consideration", and the International Code of Medical Ethics declares that, "Any act or advice which could weaken physical or mental resistance of a human being may be used only in his interest."

The purpose of biomedical research involving human subjects must be to improve diagnostic, therapeutic and prophylactic procedures; and the understanding of the aetiology and pathogenesis of the disease.

In current medical practice most diagnostic, therapeutic or prophylactic procedures involve hazards. This applies a fortiori to biomedical research.

Medical progress is based on research which ultimately must rest in part on experimentation involving human subjects. In the field of biomedical research a fundamental distinction must be recognised between medical research in which the aim is essentially diagnostic or therapeutic for a patient and medical research, in which essential objective is purely scientific and without direct diagnostic or therapeutic value to the person subjected to the research.

Special caution must be exercised in the conduct of research which may affect the environment, and the welfare of animals used for research must be respected.

Because it is essential that the results of laboratory experiments be applied to human beings to further scientific knowledge and to help suffering humanity, the World Medical Association has prepared the following recommendations as a guide to every doctor in biomedical research involving human subjects.

They should be kept under review in the future. It must be stressed that the standards as drafted are only a guide to physicians all over the world. Doctors are not relieved from criminal, civil and ethical responsibilities under the laws of their own countries.

Basic Principles

1. Biomedical research involving human subjects must conform to generally accepted scientific principles and should be based on adequately performed laboratory and animal experimentation and on a thorough knowledge of the scientific tradition.
2. The design and performance of each experimental procedure involving human subjects should be clearly formulated in an experimental protocol, which should be transmitted to a specially appointed independent committee for consideration, comment and guidance.
3. Biomedical research involving human subjects should be conducted only by scientifically qualified persons and under the supervision of a clinically competent medical person. The responsibility for the human subject must always rest with a medically qualified person and never rest on the subject of the research, even though the subject has given his/her consent.
4. Biomedical research involving human subjects cannot legitimately be carried out unless the importance of the objective is in proportion to the inherent risk to the subject.
5. Every biomedical research project involving human subjects should be preceded by careful assessment of predictable risks in comparison with foreseeable benefits to the subject or to others. Concern for the interests of the subject must always prevail over the interest of science and society.
6. The right of the research subject to safeguard his or her integrity must always be respected. Every precaution should be taken to respect the privacy of the subject and to minimise the impact of the study on the subject's physical and mental integrity and on the personality of the subject.
7. Doctors should abstain from engaging in research projects involving human subjects

unless they are satisfied that the hazards involved are believed to be predictable. Doctors should cease any investigation if the hazards are found to outweigh the potential benefits.

8. In publication of the results of his or her research, the doctor is obliged to preserve the accuracy of the results. Reports of experimentation which are not in accordance with the principles laid down in this declaration should not be accepted for publication.
9. In any research on human beings, each potential subject must be adequately informed of the aims, methods, anticipated benefits and potential hazards of the study and the discomfort it may entail. He or she should be informed that he or she is at liberty to abstain from participation in the study and that he or she is free to withdraw his or her consent to participation at any time. The doctor should then obtain the subject's freely given informed consent, preferably in writing.
10. When obtaining informed consent for the research project the doctor should be particularly cautious if the subject is in an independent relationship with him or her or may consent under duress. In that case the informed consent should be obtained by a doctor who is not engaged in investigation and who is completely independent of this official relationship.
11. In case of legal incompetence, informed consent should be obtained from the legal guardian in accordance with national legislation. Where physical or mental incapacity makes it impossible to obtain informed consent, or when the subject is a minor, permission from the responsible relative replaces that of the subject in accordance with national legislation.
12. The research protocol should always contain a statement of the ethical considerations

involved and should indicate that the principles enunciated in the present declaration are complied with.

Medical Research Combined with Professional Care (Clinical Research)

1. In the treatment of a sick person, the doctor must be free to use a new diagnostic and therapeutic measure, if in his or her judgement it offers hope of saving life, re-establishing health or alleviating suffering.
2. The potential benefits, hazards and discomfort of a new method should be weighed against the advantages of the best current diagnostic and therapeutic methods.
3. In any medical study, every patient including those of a control group, be assured of the best proven diagnostic and therapeutic method.
4. The refusal of the patient to participate in a study must never interfere with the doctor-patient relationship.
5. If the doctor considers it essential not to obtain informed consent, the specific reasons for this proposal should be stated in the experimental protocol for transmission to the independent committee.
6. The doctor can combine medical research with professional care, the objective being the acquisition of new medical knowledge, only to the extent that medical research is justified by its potential diagnostic or therapeutic value for the patient.

Non-therapeutic Biomedical Research Involving Human Subjects (Non-clinical Biomedical Research)

1. In the purely scientific application of medical research carried out on a human being, it is the duty of the doctor to remain the protector of the life and health of that person on whom biomedical research is carried out.

2. The subjects should be volunteers either healthy persons or patients for whom the experimental design is not related to the patient's illness.
3. The investigator or the investigating team should discontinue the research if in his/her or their judgement it may, if continued, be harmful to the individual.
4. In research on man, the interest of science and society should never take precedence over considerations related to the well-being of the subject.
 - If difference of opinion is there, talk to him directly and not through the patients.
 - Do not entice the patients from your colleagues.
 - If your colleague has sent some patients to you for consultation, send the patient back to him after you have done your due.
 - Do not involve in fee splitting with your colleagues.
 - If possible, an assistant should not open practice in the same area where his senior is practising.

Professional Secrecy

Secrecy is an important component of medical ethics. Whatever information physician has received during treatment should be kept confidential. It should not be divulged without the written permission of the patient. Failure to keep secrecy can lead the doctor into litigation.

Confidentiality of Medical Records

It is the duty of the doctor to keep all the medical records confidential that have originated during treatment. They can be made public only by the written permission of the patient. However, if directed by a court of law, they can be produced. Police has the power to seize medical records if some negligence is suspected. For academic benefit, the medical records can be used but the identity of the patient must be kept secret and should not be revealed by pictures or text. However, with the permission of the patient identity can be revealed.

Ethical Relations with Fellow-colleagues

Great care should be taken while dealing with fellow-colleagues and the following principles should be observed:

- Hold your fellow-colleagues as your brothers.
- Do not criticise your colleague in the presence of a patient.

MEDICAL COUNCIL

In order to regulate medical practice in India, in 1916, "Indian Medical Degrees Act" was introduced which recognised medical degrees to practice medicine. In 1933, Indian Medical Council Act 1933 was passed to safeguard the status of various medical degrees awarded by Indian universities. It also envisaged to maintain uniform standard of medical education in the country. Indian Medical Act, 1956 was enacted and Act of 1933 was repealed. The Act of 1956 introduced:

- (a) Recognition for representation of the licentiate medical practitioners.
- (b) Provision for registration of foreign medical qualifications.
- (c) Provision for formation of a committee to reorganise postgraduate medical education in the country.
- (d) Maintenance of medical register containing names of medical practitioners in India.

In 1964, this Act was amended to constitute Medical Council of India and reorganise medical education in India.

Now, in each state there is a state medical council functioning and exercising control over all medical practitioners working in the state. In New Delhi, Medical Council of India exercises control over all state medical councils.

Functions of Medical Council of India

The following are the main functions of the Medical Council of India.

1. Maintenance of Indian medical register where names of all medical practitioners working in India are registered.
2. Granting permission for establishment of new medical colleges and new courses of study.
3. Derecognition of any medical college or any course if found substandard.
4. Maintenance of standard of medical education in the country.
5. Recognition of medical qualifications granted by foreign medical universities.
6. Maintenance of standards of medical examination in various undergraduate and postgraduate courses.
7. Regulation of professional conduct and prescribe standards of professional conduct and etiquette, and a code for medical practitioner.
8. Removal of names from Indian Medical Register if a medical practitioner is found guilty.

Warning Notice

Once Medical Council of India receives a complaint against a medical practitioner about breach of professional conduct, it may issue a warning notice to him. It directs him to explain his conduct before an ethical committee.

If ethical committee finds him guilty, it can recommend:

- (a) Erasure of name of the medical practitioner for some time from Indian Medical Register.
 - (b) Permanent erasure of name of the medical practitioner from Indian Medical Register.
- If name is removed permanently, it is called **“Professional Death Sentence.”**

Infamous Conduct

When a medical practitioner acts in a disgraceful

or dishonourable manner, it is called ‘infamous conduct’ or ‘professional misconduct’. Medical Council of India has prescribed Indian Medical Council professional conduct and ethics regulations which every medical practitioner is suppose to follow by his heart and deeds.

The following are the examples of professional misconducts.

1. Non-maintenance of medical records of indoor patients for 3 years or refusal to provide such records to patient in 72 hours.
2. Non-display of registration number in clinic, prescription and certificates issued by him.
3. Adultery or improper conduct with a patient.
4. Conviction by a court of law for offences involving moral turpitudes/criminal act.
5. Conducting sex determination tests with an intention to terminate life of female foetus.
6. Signing of fake medical certificates.
7. Violating provisions of Drugs and Cosmetics Act.
8. Association with unqualified persons in discharge of medical practice.
9. Performing a criminal abortion.
10. Advertising himself except as provided under rules.
11. Revealing professional secrets of the patient except as provided under rules.
12. Refusal of treatment on religious grounds.
13. Informed consent not taken.
14. Should not publish photographs of patient without consent.
15. Dichotomy or sharing of professional fees with fellow practitioners.
16. Use of touts or agents for procuring patients.
17. Doing illegal *in vitro* fertilisation without informed consent of the patient and her spouse as well as the donor.
18. Absence from duty.
19. Violation of research guidelines.

The details of above misconducts are provided later in this chapter in Indian Medical Council (Professional Conduct and Ethics) Regulation, 2002.

The Indian Medical Council of India Act, 1956 is here given in detail to understand composition, functions and powers of the Medical Council of India.

MEDICAL COUNCIL OF INDIA

An act to provide for the reconstitution of the Medical Council of India, and the maintenance of a Medical Register for India and for matters connected therewith.

(30th December, 1956)

Be it enacted by Parliament in the Seventh Year of the Republic of India as follows:

1. Short Title, Extent and Commencement:

- (1) This Act may be called the Indian Medical Council Act, 1956.
- (2) It extends to the whole of India.
- (3) It shall come into force on such date as the Central Government may, by notification in the Official Gazette, appoint.

2. Definitions: In this Act, unless the context otherwise requires:

- (a) “approved institution” means a hospital, health centre or other such institution recognised by a University as an institution in which a person may undergo the training, if any, required by his course of study before the award of any medical qualification to him;
- (b) “council” means the Medical Council of India constituted under this Act;
- (c) “Indian Medical Register” means the medical register maintained by the Council;
- (d) “Medical institution” means any institution, within or outside India, which grants degrees, diplomas or licences in medicine;
- (e) “medicine” means modern scientific medicine in all its branches and includes surgery and obstetrics, but does not include veterinary medicine and surgery;

- (f) “prescribed” means prescribed by regulations;
- (g) “recognised medical qualification” means any of the medical qualifications included in the schedules;
- (h) “regulation” means a regulation made under Section 33;
- (i) “State Medical Council” means a medical council constituted under any law for the time being in force in any State regulating the registration of practitioners of medicine;
- (j) “State Medical Register” means a register maintained under any law for the time being in force in any State regulating the registration of practitioners of medicine;
- (k) “University” means any university in India established by law and having a medical faculty.

3. Constitution and Composition of the Council:

- (1) The Central Government shall cause to be constituted a Council consisting of the following members, namely:
 - (a) one member from each State other than a Union Territory, to be nominated by the Central Government in consultation with the State Government concerned;
 - (b) one member from each University, to be elected from amongst the members of the medical faculty of the University by members of the Senate of the University or, in case the University has no Senate, by members of the Court.
 - (c) one member from each State in which a State Medical Register is maintained, to be elected from amongst themselves by persons enrolled on such Register who possess the medical qualifications included in the First or the Second Schedule or in Part II of the Third Schedule.
 - (d) seven members to be elected from amongst themselves by persons enrolled

on any of the State Medical Registers who possess the medical qualifications included in Part I of the Third Schedule.

- (e) eight members to be nominated by the Central Government.
- 2. The President and Vice-president of the Council shall be elected by the members of the Council from amongst themselves.
- 3. No act, done by the Council shall be questioned on the ground merely of the existence of any vacancy in, or any defect in the constitution of the Council.

4. Mode of Election:

- 1. An election under clause (b), clause (c) or clause (d) of sub-section (1) of Section 3 shall be conducted by the Central Government in accordance with such rules as may be made by it in this behalf, and any rules so made may provide that pending the preparation of the Indian Medical Register in accordance with the provisions of this Act, the members referred to in clause (d) of sub-section (1) of Section 3 may be nominated by the Central Government instead of being elected as provided therein.
- 2. Where any dispute arises regarding any election to the Council, it shall be referred to the Central Government whose decision shall be final.

5. Restrictions on Nomination and Membership:

- 1. No person shall be eligible for nomination under clause (a) of sub-section (1) of Section 3 unless he possesses any of the medical qualifications included in the First and Second Schedules, resides in the State concerned, and, where a State Medical Register is maintained in that State is enrolled on that register.
- 2. No person may at the same time serve as a member in more than one capacity.

6. Incorporation of the Council: The Council so constituted shall be a body corporate by the name of the Medical Council of India, having perpetual succession and a common seal, with power to acquire and hold property, both movable and immovable, and to contract, and shall by the said name sue and be sued.

7. Term of Office of President, Vice-President and Members:

- 1. The President or Vice-President of the council shall hold office for a term not exceeding five years, and not extending beyond the expiry of his term as member of the Council.
- 2. Subject to the provisions of this Section, a member shall hold office for a term of five years from the date of his nomination or election or until his successor shall have been duly nominated or elected, whichever is longer.
- 3. An elected or nominated member shall be deemed to have vacated his seat if he is absent without excuse, sufficient in the opinion of the Council, from three consecutive ordinary meetings of the Council or, in the case of a member elected under clause (b) of subsection (1) of Section 3, if he ceases to be a member of the medical faculty of the University concerned, or in the case of a member elected under clause (c) or clause (d) of that sub-section, if he ceases to be a person enrolled on the State Medical Register concerned.
- 4. A casual vacancy in the Council shall be filled by nomination or election, as the case may be, and the person nominated or elected to fill the vacancy shall hold office only for the remainder of the term for which the member whose place he takes was nominated or elected.
- 5. Members of the Council shall be eligible for re-nomination or re-election.

6. Where the said term of five years is about to expire in respect of any member, a successor may be nominated or elected at any time within three months before the said term expires but he shall not assume office until the said term has expired.

8. Meetings of the Council

1. The Council shall meet at least once in each year at such time and place as may be appointed by the Council.
2. Unless otherwise provided by regulations, fifteen members of the Council shall form a quorum, and all the acts of the Council shall be decided by a majority of the members present and voting.

9. Officers, Committees and Servants of the Council: The Council shall:

1. Constitute from amongst its members an Executive Committee and such other Committees for general or special purposes as the Council deems necessary to carry out the purposes of this Act;
2. Appoint a Registrar who shall act as Secretary and who may also, if deemed expedient, act as Treasurer;
3. Employ such other persons as the Council deems necessary to carry out the purposes of this Act;
4. Require and take from the Registrar, or from any other employee, such security for the due performance of his duties as the Council deems necessary; and
5. With the previous sanction of the Central Government, fix the remuneration and allowances to be paid to the President, Vice-President and member of the Council and determine the conditions of service of the employees of the Council.

10. The Executive Committee:

1. The Executive Committee, hereinafter referred to as the Committee, shall consist

of the President and Vice-President, who shall be members *ex officio*, and not less than seven and not more than ten members who shall be elected by the Council from amongst its members.

2. The President and Vice-President shall be the President and Vice-President, respectively, of the Committee.
3. In addition to the powers and duties conferred and imposed upon it by this Act, the Committee shall exercise and discharge such powers and duties as the Council may confer or impose upon it by any regulations which may be made in this behalf.

10A. Permission for Establishment of New Medical College, New Course of Study, etc.

1. Notwithstanding anything contained in this Act or any other law for the time being in force:
 - (a) no person shall establish a medical college, or
 - (b) no medical college shall
 - (i) open a new or higher course of study or training (including a postgraduate course of study or training) which would enable a student of such course or training to qualify himself for the award of any recognised medical qualification; or
 - (ii) increase its admission capacity in any course of study or training (including a postgraduate course of study or training), except with the previous permission of the Central Government obtained in accordance with the provisions of this section.

Explanation 1—For the purposes of this section, “person” includes any university or a trust but does not include the Central Government.

Explanation 2—For the purposes of this section, “admission capacity” in relation to any course of study or training (including postgraduate, course of study or training) in a medical college, means the maximum number of students that may be fixed by the Council from time to time for being admitted to such course or training.

2. (a) Every person or medical college shall for the purpose of obtaining permission under sub-section (1), submit to Central Government a scheme in accordance with the provisions of clause (b) and the Central Government shall refer the scheme to the Council for its recommendations.
- (b) The scheme referred to in clause (a) shall be in such form and contain such particulars and be preferred in such manner and be accompanied with such fee as may be prescribed.
3. On receipt of a scheme by the Council under sub-section (2), the Council may obtain such other particulars as may be considered necessary by it from the person or the medical college concerned, and thereafter, it may
 - (a) if the scheme is defective and does not contain any necessary particulars, give a reasonable opportunity to the person or college concerned for making a written representation and it shall be open to such person or medical college to rectify the defects, if any, specified by the Council;
 - (b) consider the scheme, having regard to the factors referred to in sub-section (7), and submit the scheme together with the recommendations thereon to the Central Government.
4. The Central Government may after considering the scheme and the recommendations of the Council under sub-section (3) and after obtaining, where necessary, such other particulars as may be considered necessary by it from the person or college concerned, and having regard to the factors referred to in sub-section (7), either approve (with such conditions, if any, as it may consider necessary) or disapprove the scheme and any such approval shall be a permission under sub-section (1):

Provided that no scheme shall be disapproved by the Central Government except after giving the person or college concerned a reasonable opportunity of being heard;

Provided further that nothing in this sub-section shall prevent any person or medical college whose scheme has not been approved by the Central Government to submit a fresh scheme and the provisions of this section shall apply to such scheme, as if such scheme has been submitted for the first time under sub-section (1).
5. Where, within a period of one year from the date of submission of the scheme to the Central Government under sub-section (1), no order passed by the Central Government has been communicated to the person or college submitting the scheme, such scheme shall be deemed to have been approved by the Central Government in the form in which it had been submitted, and accordingly, the permission of the Central Government required under sub-section (1) shall also be deemed to have been granted.
6. In computing the time-limit specified in sub-section (5), the time taken by the person or college concerned submitting the scheme, in furnishing any particulars called for by the Council, or by the Central Government, shall be excluded.

7. The Council, while making its recommendations under clause (b) of sub-section (3) and the Central Government, while passing an order, either approving or disapproving the scheme under sub-section (4) shall have due regard to the following factors, namely:
- (a) whether the proposed medical college or the existing medical college seeking to open a new or higher course of study or training, would be in a position to offer the minimum standards of medical education as prescribed by the Council under Section 19A or, as the case may be, under Section 20 in the case of postgraduate medical education;
 - (b) whether the person seeking to establish a medical college or the existing medical college seeking to open a new or higher course of study or training or to increase its admission capacity has adequate financial resources;
 - (c) whether necessary facilities in respect of staff, equipment, accommodation, training and other facilities to ensure proper functioning of the medical college or conducting the new course of study or training or accommodating the increased admission capacity have been provided or would be provided within the time limit specified in the scheme;
 - (d) whether adequate hospital facilities, having regard to the number of students likely to attend such medical college or course of study or training or as a result of the increased admission capacity have been provided or would be provided within the time limit specified in the scheme;
 - (e) whether any arrangement has been made or programme drawn to impart proper training to students likely to attend such medical college or course of study or training by persons having the recognised medical qualifications;
 - (f) the requirement of manpower in the field of practice of medicine; and
 - (g) any other factors as may be prescribed.
8. Where the Central Government passes an order either approving or disapproving a scheme under this section, a copy of the order shall be communicated to the person or college concerned.
- 10B. Non-recognition of Medical Qualifications in Certain Cases:**
1. Where any medical college is established except with the previous permission of the Central Government in accordance with the provisions of Section 10A, no medical qualification granted to any student of such medical college shall be a recognised medical qualification for the purposes of this Act.
 2. Where any medical college opens a new or higher course of study or training (including a postgraduate course of study or training) except with the previous permission of the Central Government in accordance with the provisions of Section 10A, no medical qualification granted to any student of such medical college on the basis of such study or training shall be a recognised medical qualification for the purposes of this Act.
 3. Where any medical college increases its admission capacity in any course of study or training except with the previous permission of the Central Government in accordance with the provisions of Section 10A, no medical qualification granted to any student of such medical college on the basis of the increase in its admission capacity shall be a recognised medical qualification for the purposes of this Act.
- Explanation – For the purposes of this section, the certificate for identifying a student who has been granted a medical qualification on the basis of such increase in the admission capacity shall be such as may be prescribed.

10C. Time for Seeking Permission for Certain Existing Medical Colleges, etc.:

1. If, after the 1st day of June, 1992 and on and before the commencement of the Indian Medical Council (Amendment) Act, 1993 any person has established a medical college or any medical college has opened a new or higher course of study or training or increased the admission capacity, such person or medical college, as the case may be, shall seek, within a period of one year from the commencement of the Indian Medical Council (Amendment) Act, 1993, the permission of the Central Government in accordance with the provisions of Section 10A.
2. If any person or medical college, as the case may be fails to seek the permission under sub-section (1), the provisions of Section 10B shall apply, so far as may be as if, permission of the Central Government under Section 10A has been refused.

11. Recognition of Medical Qualification granted by Universities or Medical Institutions in India:

1. The medical qualifications granted by any university or medical institution in India which are included in the First Schedule shall be recognised medical qualifications for the purposes of this Act.
2. Any university or medical institution in India which grants a medical qualification not included in the First Schedule may apply to the Central Government to have such qualification recognised, and the Central Government, after consulting the Council, may, by notification in the Official Gazette, amend the First Schedule so as to include such qualifications therein, and any such notification may also direct that an entry shall be made in the last column of the First Schedule against such medical qualification declaring that it shall be a recognised medical qualification only when granted after a specified date.

12. Recognition of Medical Qualifications Granted by Medical Institutions in Countries with which there is a Scheme of Reciprocity:

1. The medical qualifications granted by medical institutions outside India which are included in the Second Schedule shall be recognised medical qualifications for the purposes of this Act.
2. The Council may enter into negotiations with the Authority in any country outside India which by the law of such country is entrusted with the maintenance of a register of medical practitioners, for the settling of a scheme of reciprocity for the recognition of medical qualifications, and in pursuance of any such scheme, the Central Government may, by notification in the Official Gazette, amend the Second Schedule so as to include therein the medical qualification which the Council has decided should be recognised, and any such notification may also direct that an entry shall be made in the last column of the Second Schedule against such medical qualification declaring that it shall be a recognised medical qualification only when granted after a specified date.
3. The Central Government, after consultation with the Council, may, by notification in the Official Gazette, amend the Second Schedule by directing that an entry be made therein in respect of any medical qualification declaring that it shall be a recognised medical qualification only when granted before a specified date.
4. Where the Council has refused to recommend any medical qualification which has been proposed for recognition by any Authority referred to in sub-section (2) and that Authority applies to the Central Government in this behalf, the Central Government, after considering such application and after obtaining from the council a report, if any, as to the reasons for

any such refusal, may, by notification in the Official Gazette, amend the Second Schedule so as to include such qualification therein and the provisions of sub-section (2) shall apply to such notification.

13. Recognition of Medical Qualifications Granted by Certain Medical Institutions whose Qualifications are Not Included in the First or Second Schedule:

1. The medical qualifications granted by medical institutions in India which are not included in the First Schedule and which are included in Part I of the Third Schedule shall also be recognised medical qualifications for the purposes of this Act.
2. The medical qualifications granted to a citizen of India:
 - (a) before the 15th day of August, 1947, by medical institutions in the territories now forming part of Pakistan, and,
 - (b) before the 1st day of April, 1937, by medical institutions in the territories now forming part of Burma, which are included in Part I of the Third Schedule shall also be recognised medical qualifications for the purposes of this Act.
3. The medical qualifications granted by medical institutions outside India which are included in Part II of the Third Schedule shall also be recognised medical qualifications for the purposes of this Act, but no person possessing any such qualification shall be entitled to enrolment on any State Medical Register unless he is a citizen of India and has undergone such practical training after obtaining that qualification as may be required by the rules or regulations in force in the country granting the qualification, or if he has not undergone any practical training in that

country he has undergone such practical training as may be prescribed.

4. The Central Government, after consulting the Council, may by notification in the Official Gazette, amend Part II of the Third Schedule so as to include therein any qualification granted by a medical institution outside India, which is not included in the Second Schedule.
 5. Any medical institution in India which is desirous of getting a medical qualification granted by it included in Part I of the Third Schedule may apply to the Central Government to have such qualification recognised and the Central Government, after consulting the Council, may, by notification in the Official Gazette, amend Part I of the Third Schedule so as to include such qualification therein, and any such notification may also direct that an entry shall be made in the last column of Part I of the Third Schedule against such medical qualification declaring that it shall be a recognised medical qualification only when granted after a specified date.
- 14. Special Provision in Certain Cases for Recognition of Medical Qualifications Granted by Medical Institutions in Countries with which there is No Scheme of Reciprocity:**
1. The Central Government after consultation with the Council may, by notification in the Official Gazette, direct that medical qualifications granted by medical institutions in any country outside India in respect of which a scheme of reciprocity for the recognition of medical qualifications is not in force, shall be recognised medical qualification for the purposes of this Act or shall be so only when granted after a specified date:

Provided that medical practice by persons possessing such qualifications:

- (a) shall be permitted only if such persons are enrolled as medical practitioners in accordance with the law regulating the registration of medical practitioners for the time being in force in that country;
 - (b) shall be limited to the institution to which they are attached for the time being for the purposes of teaching, research or charitable work; and
 - (c) shall be limited to the period specified in this behalf by the Central Government by general or special order.
2. In respect of any such medical qualification, the Central Government, after consultation with the council, may, by notification in the Official Gazette, direct that it shall be a recognised medical qualification only when granted before a specified date.

15. Right of Persons Possessing Qualifications in the Schedules to be Enrolled:

1. Subject to the other provisions contained in this Act, the medical qualifications included in the Schedules shall be sufficient qualification for enrolment on any State Medical Register.
2. Save as provided in Section 25, no person other than a medical practitioner enrolled on a State Medical Register:
 - (a) shall hold office as physician or surgeon or any other office (by whatever designation called) in Government or in any institution maintained by a local or other authority;
 - (b) shall practise medicine in any state;
 - (c) shall be entitled to sign or authenticate a medical or fitness certificate or any other certificate required by any law to be signed or authenticated by a duly qualified medical practitioner.
 - (d) shall be entitled to give evidence at any inquest or in any court of law as an expert under Section 45 of the Indian Evidence Act, 1872 on any matter relating to medicine.

3. Any person who acts in contravention of any provision of sub-section (2) shall be punished with imprisonment for a term which may extend to one year, or with fine which may extend to one thousand rupees, or with both.

16. Power to Require Information as to Courses of Study and Examinations:

Every university or medical institution in India which grants a recognised medical qualification shall furnish such information as the Council may, from time to time, require as to the courses of study and examinations to be undergone in order to obtain such qualification, as to the ages at which such courses of study and examinations are required to be undergone and such qualification is conferred and generally as to the requisites for obtaining such qualification.

17. Inspection of Examinations:

1. The Committee shall appoint such number of medical inspectors as it may deem requisite to inspect any medical institution, college, hospital or other institution where medical education is given or to attend any examination held by any university or medical institution for the purpose of recommending to the Central Government recognition of medical qualifications granted by that university or medical institution.
2. The medical inspectors shall not interfere with the conduct of any training or examination, but shall report to the Committee on the adequacy of the standards of medical education including staff, equipment, accommodation, training and other facilities prescribed for giving medical education or on the sufficiency of every examination which they attend.
3. The Committee shall forward a copy of any such report to the university or medical institution concerned, and shall also forward

a copy with the remarks of the university or institution thereon, to the Central Government.

18. Visitors at Examinations:

1. The Council may appoint such number of visitors as it may deem requisite to inspect any medical institution, college, hospital or other institution where medical education is given or to attend any examination held by any university or medical institution for the purpose of granting recognised medical qualifications.
2. Any person, whether he is a member of the Council or not, may be appointed as a visitor under this section but a person who is appointed as an inspector under Section 17 for any inspection or examination shall not be appointed as a visitor for the same inspection or examination.
3. The visitors shall not interfere with the conduct of any training or examination, but shall report to the President of the Council on the adequacy of the standards of medical education including staff, equipment, accommodation, training and other facilities prescribed for giving medical education or on the sufficiency of every examination which they attend.
4. The report of a visitor shall be treated as confidential unless in any particular case the President of the Council otherwise directs:
 Provided that if the Central Government requires a copy of the report of a visitor, the Council shall furnish the same.

19. Withdrawal of Recognition:

1. When upon report by the Committee or the visitor it appears to the Council:
 - (a) that the courses of study and examination to be undergone in, or the proficiency required from candidates at any examination held by any university or medical institution,
 - (b) that the staff, equipment, accommodation, training and other facilities

for instruction and training provided in such university or medical institution or in any college or other institution affiliated to that university, do not conform to the standards prescribed by the Council, the Council shall make a representation to that effect to the Central Government.

2. After considering such representation, the Central Government may send it to the Government of the State in which the university or medical institution is situated and the State Government shall forward it along with such remarks as it may choose to make to the university or medical institution, with an intimation of the period within which the university or medical institution may submit its explanation to the State Government.
3. On the receipt of the explanation or, where no explanation is submitted within the period fixed, then on the expiry of that period the State Government shall make its recommendations to the Central Government.
4. The Central Government, after making such further inquiry, if any, as it may think fit, may, by notification in the Official Gazette, direct that an entry shall be made in the appropriate Schedule against the said medical qualification declaring that it shall be a recognised medical qualification only when granted before a specified date or that the said medical qualification if granted to students of a specified college or institution affiliated to any university shall be a recognised medical qualification only when granted before a specified date or, as the case may be, that the said medical qualification shall be a recognised medical qualification in relation to a specified college or institution affiliated to any university only when granted after a specified date.

19A. Minimum Standards of Medical Education:

1. The Council may prescribe the minimum standards of medical education required for granting recognised medical qualifications (other than postgraduate medical qualifications) by universities or medical institutions in India.
2. Copies of the draft regulations and of all subsequent amendments thereof shall be furnished by the Council to all State Governments and the Council shall before submitting the regulations or any amendment thereof, as the case may be, to the Central Government for sanction, take into consideration the comments of any state government received within three months from the furnishing of the copies as aforesaid.
3. The Committee shall from time to time report to the Council on the efficacy of the regulations and may recommend to the Council such amendments thereof as it may think fit.

20. Postgraduate Medical Education Committee for Assisting Council in Matters Relating to Postgraduate Medical Education:

1. The Council may prescribe standards of postgraduate medical education for the guidance of universities, and may advise universities in the matter of securing uniform standards for postgraduate medical education throughout India, and for this purpose the Central Government may constitute from among the members of the Council a Postgraduate Medical Education Committee (hereinafter referred to as the Postgraduate Committee).
2. The Postgraduate Committee shall consist of nine members all of whom shall be persons possessing postgraduate medical qualifications and experience of teaching or

examining postgraduate students of medicine.

3. Six of the members of the Postgraduate Committee shall be nominated by the Central Government and the remaining three members shall be elected by the Council from amongst its members.
4. For the purpose of considering postgraduate studies in a subject, the Postgraduate Committee may co-opt, as and when necessary, one or more members qualified to assist it in that subject.
5. The views and recommendations of the Postgraduate Committee on all matters shall be placed before the Council, and if the Council does not agree with the views expressed or the recommendations made by the Postgraduate Committee on any matter, the Council shall forward them together with its observations to the Central Government for decision.

20A. Professional Conduct:

1. The Council may prescribe standards of professional conduct and etiquette and a code of ethics for medical practitioners.
2. Regulations made by the Council under subsection (1) may specify which violations thereof shall constitute infamous conduct in any professional respect, that is to say, professional misconduct, and such provisions shall have effect notwithstanding anything contained in any law for the time being in force.

21. The Indian Medical Register:

1. The Council shall cause to be maintained in the prescribed manner a register of medical practitioners to be known as the Indian Medical Register, which shall contain the names of all persons who are for the time being enrolled on any State Medical Register and who possess any of the recognised medical qualifications.
2. It shall be the duty of the Registrar of the Council to keep the Indian Medical Register

in accordance with the provisions of this Act and of any orders made by the Council, and from time to time to revise the register and publish it in the Gazette of India and in such other manner as may be prescribed.

3. Such register shall be deemed to be a public document within the meaning of the Indian Evidence Act, 1872 (1 of 1872), and may be proved by a copy published in the Gazette of India.

22. Supply of Copies of the State Medical Registers:

Each State Medical Council shall supply to the Council six printed copies of the State Medical Register as soon as may be after the commencement of this Act and subsequently after the first day of April of each year, and each Registrar of a State Medical Council shall inform the Council without delay of all additions to and other amendments in the State Medical Register made from time to time.

23. Registration in the Indian Medical Register:

The Registrar of the Council, may, on receipt of the report of registration of a person in a State Medical Register or on application made in the prescribed by any such person, enter his name in the Indian Medical Register:

Provided that the Registrar is satisfied that the person concerned possesses a recognised medical qualification.

24. Removal of Names from the Indian Medical Register:

1. If the name of any person enrolled on State Medical Register is removed therefrom in pursuance of any power conferred by or under any law relating to registration of medical practitioners for the time being in force in any State, the Council shall direct the removal of the name of such person from the Indian Medical Register.
2. Where the name of any person has been removed from a State Medical Register on

the ground of professional misconduct or any other ground except that he is not possessed of the requisite medical qualifications or where any application made by the said person for restoration of his name to the State Medical Register has been rejected he may appeal in the prescribed manner and subject to such conditions including conditions as to the payment of a fee as may be laid down in rules made by the Central Government in this behalf, to the Central Government, whose decision, which shall be given after consulting the Council, shall be binding on the State Government and on the authorities concerned with the preparation of the State Medical Register.

25. Provisional Registration:

1. A citizen of India possessing a medical qualification granted by a medical institution outside India included in Part II of the Third Schedule, who is required to undergo practical training as prescribed under sub-section (3) of Section 13, shall, on production of proper evidence that he has been selected for such practical training in an approved institution, be entitled to be registered provisionally in a State Medical Register and shall be entitled to practice medicine in the approved institution for the purposes of such training and for no other purpose.
2. A person who has passed the qualifying examination of any university or medical institution in India for the grant of a recognised medical qualification shall be entitled to be registered provisionally in a State Medical Register for the purpose of enabling him to be engaged in employment in a resident medical capacity in any approved institution, or in the Medical Service of the Armed Forces of the Union, and for no other purpose, on production of proper evidence that he has been selected for such employment.

3. The names of all persons provisionally registered under sub-section (1) or sub-section (2) in the State Medical Register shall be entered therein separately from the names of other persons registered therein.
4. A person registered provisionally as aforesaid who has completed practical training referred to in sub-section (1) or who has been engaged for the prescribed period in employment in a resident medical capacity in any approved institution or in the Medical Service of the Armed Forces of the Union, as the case may be, shall be entitled to registration in the State Medical Register under Section 15.

26. Registration of Additional Qualification:

1. If any person whose name is entered in the Indian Medical Register obtains any title, diploma or other qualification for proficiency in sanitary science, public health or medicine, which is a recognised medical qualification, he shall, on application made in this behalf in the prescribed manner, be entitled to have an entry stating such other title, diploma, or other qualification made against his name in the Indian Medical Register either in substitution for or in addition to any entry previously made.
2. The entries in respect of any such person in a State Medical Register shall be altered in accordance with the alterations made in the Indian Medical Register.

27. Privileges of Persons who are Enrolled on the Indian Medical Register: Subject to the conditions and restrictions laid down in this Act regarding medical practice by persons possessing certain recognised medical qualifications, every person whose name is for the time being borne on the Indian Medical Register shall be entitled according to his qualifications to practise as a medical practitioner in any part of India and to recover in due course of law in respect of such practice

any expenses, charges in respect of medicament or other appliances, or any fees to which he may be entitled.

28. Person Enrolled on the Indian Medical Register to Notify Change of Place of Residence or Practice:

Every person registered in the Indian Medical Register shall notify any transfer of the place of his residence or practice to the Council and to the State Medical Council concerned, within thirty days of such transfer, failing which his right to participate in the election of members to the Council or a State Medical Council shall be liable to be forfeited by order of the Central Government either permanently or for such period as may be specified therein.

29. Information to be Furnished by the Council and Publication thereof:

1. The Council shall furnish such reports, copies of its minutes, abstracts of its accounts, and other information to the Central Government as that Government may require.
2. The Central Government may publish in such manner as it may think fit, any report, copy, abstract or other information furnished to it under this section or under Sections 17 and 18.

30. Commissions of Inquiry:

1. Whenever it is made to appear to the Central Government that the Council is not complying with any of the provisions of this Act, the Central Government may refer the particulars of the complaint to a Commission of Inquiry consisting of three persons, two of whom shall be appointed by the Central Government, one being a Judge of a High Court, and one by the Council, and such Commission shall proceed to inquire in a summary manner and to report to the Central Government as to the truth of the matters charged in the complaint, and in case of any charge of

default or of improper action being found by the Commission to have been established, the Commission shall recommend the remedies, if any, which are in its opinion necessary.

2. The Central Government may require the Council to adopt the remedies so recommended within such time as, having regard to the report of the Commission, it may think fit, and if the Council fails to comply with any such requirement, the Central Government may amend the regulations of the Council or make such provision or order or take such other steps as may seem necessary to give effect to the recommendations of the Commission.
3. A Commission of Inquiry shall have power to administer oaths, to enforce the attendance of witnesses and the production of documents, and shall have all such other necessary powers for the purpose of any inquiry conducted by it as are exercised by a civil court under the Code of Civil Procedure, 1908 (5 of 1908).

31. Protection of Action taken in Good Faith:

No suit, prosecution or other legal proceeding shall lie against the Government, the Council or a State Medical Council or any Committee thereof, or any officer or servant of the Government or Councils aforesaid for anything which is in good faith done or intended to be done under this Act.

32. Power to Make Rules:

1. The Central Government may, by notification in the Official Gazette, make rules to carry out the purposes of this Act.
2. All rules made under this section shall be laid or not less than thirty days before both Houses of Parliament as soon as possible after they are made, and shall be subject to such modifications as Parliament may make during the session in which they are so laid or the session immediately following.

33. Power to Make Regulations: The Council may, with the previous sanction of the Central Government, make regulations generally to carry out the purposes of this Act, and, without prejudice to the generality of this power, such regulations may provide for:

- (a) the management of the property of the Council and the maintenance and audit of its accounts;
- (b) the summoning and holding of meetings of the Council, the times and places where such meetings are to be held, the conduct of business thereat and the number of members necessary to constitute a quorum;
- (c) the resignation of members of the Council;
- (d) the power and duties of the President and Vice-President;
- (e) the mode of appointment of the Executive Committee and other committees, the summoning and holding of meetings, and the conduct of business of such committees;
- (f) the tenure of office, and the powers and duties of the Registrar and other officers and servants of the Council:
 - (i) the form of the scheme, the particulars to be given in such scheme, the manner in which the scheme is to be preferred and the fee payable with the scheme under clause (b) of sub-section (2) of Section 10A;
 - (ii) any other factors under Clause (g) of sub-section (7) of Section 10A;
 - (iii) the criteria for identifying a student who has been granted a medical qualification referred to in the explanation to sub-section (3) of Section 10B;
- (g) the particulars to be stated, and the proof of qualifications to be given the applications for registration under this Act;
- (h) the fees to be paid on applications and appeals under this Act;
- (i) the appointment, powers, duties and procedure of medical inspectors and visitors;

- (j) the courses and period of study and of practical training to be undertaken, the subjects of examination and the standards of proficiency therein to be obtained, in universities or medical institutions for grant of recognised medical qualifications;
 - (k) the standards of staff, equipment, accommodation, training and other facilities for medical education;
 - (l) the conduct of professional examinations, qualifications of examiners and the conditions of admission to such examinations;
 - (m) the standards of professional conduct and etiquette and code of ethics to be observed by medical practitioners; and
 - (i) the modalities for conducting screening tests under sub-section (4A), and under proviso to sub-section (4B) and for issuing eligibility certificate under sub-section (4B) of Section 13;
 - (n) any matter for which under this Act provision may be made by regulations.
- and may exercise any of the powers conferred or perform any of the duties imposed on the Council; and any vacancy occurring in the said Medical Council may be filled up in such manner as the Central Government may think fit; and
- (b) the Executive Committee and other Committees of the said Medical Council as constituted immediately before the commencement of this Act, shall be deemed to be the Executive Committee and other Committees constituted under this Act.

NEW ETHICAL REGULATIONS FROM MEDICAL COUNCIL OF INDIA

These Regulations may be called the Indian Medical Council (professional conduct, and ethics) Regulations, 2002 and they are binding on all doctors in India.

34. Repeal of Act 27 of 1933:

1. The Indian Medical Council Act, 1933, is hereby repealed.
2. Notwithstanding anything contained in this Act, until the Council is constituted in accordance with the provisions of this Act:
 - (a) the Medical Council of India as constituted immediately before the commencement of this Act under the Indian Medical Council Act, 1933 (27 of 1933), with the addition of seven members nominated thereto by the Central Government from among persons enrolled on any of the State Medical Registers who possess the medical qualifications included in Part I of the Third Schedule to this Act (hereinafter referred to as the said Medical Council), shall be deemed to be the Council constituted under this Act

CHAPTER 1

1. Code of Medical Ethics

A. Declaration

Each applicant, at the time of making an application for registration under the provisions of the Act, shall be provided a copy of the declaration and shall submit a duly signed Declaration as provided in Appendix 1. The applicant shall also certify that he/she had read and agreed to abide by the same.

B. Duties and Responsibilities of the Physician in General

- 1.1 **Character of physician:** (Doctors with qualification of MBBS or MBBS with post-graduate degree/diploma or with equivalent qualification in any medical discipline):
 - 1.1.1 A physician shall uphold the dignity and honour of his profession.

1.1.2 The prime object of the medical profession is to render service to humanity; reward or financial gain is a subordinate consideration. Whosoever chooses his profession, assumes the obligation to conduct himself in accordance with its ideals. A physician should be an upright man, instructed in the art of healing. He shall keep himself pure in character and be diligent in caring for the sick; he should be modest, sober, patient, prompt in discharging his duty without anxiety; conducting himself with propriety in his profession and in all the actions of his life.

1.1.3 No person other than a doctor having qualification recognised by Medical Council of India and registered with Medical Council of India/State Medical Council(s) is allowed to practise modern system of medicine or surgery. A person obtaining qualification in any other system of medicine is not allowed to practise modern system of medicine in any form.

1.2 **Maintaining good medical practice:**

1.2.1 The principal objective of the medical profession is to render service to humanity with full respect for the dignity of profession and man. Physicians should merit the confidence of patients entrusted to their care, rendering to each a full measure of service and devotion. Physicians should try continuously to improve medical knowledge and skills and should make available to their patients and colleagues the benefits of their professional attainments. The physician should practise methods of healing founded on scientific basis and should not associate professionally with anyone who violates this principle. The honoured ideals of the medical profession imply that the responsibilities

of the physician extend not only to individuals but also to society.

1.2.2 **Membership in Medical Society:** For the advancement of his profession, a physician should affiliate with associations and societies of allopathic medical professions and involve actively in the functioning of such bodies.

1.2.3 A physician should participate in professional meeting as part of Continuing Medical Education programmes, for at least 30 hours every five years, organised by reputed professional academic bodies or any other authorised organisations. The compliance of this requirement shall be informed regularly, to Medical Council of India or the State Medical Councils as the case may be.

1.3 **Maintenance of medical records:**

1.3.1 Every physician shall maintain the medical records pertaining to his/her indoor patients for a period of 3 years from the date of commencement of the treatment in a standard proforma laid down by the Medical Council of India and attached as Appendix 3.

1.3.2 If any request is made for medical records either by the patients/authorised attendant or legal authorities involved, the same may be duly acknowledged and documents shall be issued within the period of 72 hours.

1.3.3 A registered medical practitioner shall maintain a Register of Medical Certificates giving full details of certificates issued. When issuing a medical certificate he/ she shall always enter the identification marks of the patient and keep a copy of the certificate. He/she shall not omit to record the signature and/or thumb mark, address and at least one identification mark of the patient on the medical certificates or

report. The medical certificate shall be prepared as in Appendix 2.

- 1.3.4 Efforts shall be made to computerise medical records for quick retrieval.

1.4 Display of registration numbers:

1.4.1 Every physician shall display the registration number accorded to him by the State Medical Council/Medical Council of India in his clinic and in all his prescriptions, certificates, money receipts given to his patients.

1.4.2 Physicians shall display as suffix to their names only recognised medical degrees or such certificates/diplomas and memberships/honours which confer professional knowledge or recognises any exemplary qualification/achievements.

1.5 Use of generic names of drugs: Every physician should, as far as possible, prescribe drugs with generic names and he/she shall ensure that there is a rational prescription and use of drugs.

1.6 Highest quality assurance in patient care: Every physician should aid in safeguarding the profession against admission to it of those who are deficient in moral character or education. Physician shall not employ in connection with his professional practice any attendant who is neither registered nor enlisted under the Medical Acts in force and shall not permit such persons to attend, treat or perform operations upon patients wherever professional discretion or skill is required.

1.7 Exposure of unethical conduct: A physician should expose, without fear or favour, incompetent or corrupt, dishonest or unethical conduct on the part of members of the profession.

1.8 Payment of professional services: The physician, engaged in the practice of medicine shall give priority to the interests of patients. The personal financial interests of a physician should not conflict with the medical interests of patients. A physician

should announce his fees before rendering service and not after the operation or treatment is under way. Remuneration received for such services should be in the form and amount specifically announced to the patient at the time the service is rendered. It is unethical to enter into a contract of “no cure no payment”. Physician rendering service on behalf of the state shall refrain from anticipating or accepting any consideration.

1.9 Evasion of legal restrictions: The physician shall observe the laws of the country in regulating the practice of medicine and shall also not assist others to evade such laws. He should be cooperative in observance and enforcement of sanitary laws and regulations in the interest of public health. A physician should observe the provisions of the State Acts like Drugs and Cosmetics Act, 1940; Pharmacy Act, 1948; Narcotic Drugs and Psychotropic Substances Act, 1985; Medical Termination of Pregnancy Act, 1971; Transplantation of Human Organ Act, 1994; Mental Health Act, 1987; Environmental Protection Act, 1986; Pre-natal Sex Determination Test Act, 1994; Drugs and Magic Remedies (Objectionable Advertisement) Act, 1954; Persons with Disabilities (Equal Opportunities and Full Participation) Act, 1995 and Bio-medical Waste (Management and Handling) Rules, 1998 and such other Acts, Rules, Regulations made by the Central/State Governments or Local Administrative Bodies or any other relevant Act relating to the protection and promotion of public health.

CHAPTER 2

2. Duties of Physicians to their Patients

2.1 Obligations to the sick:

2.1.1 Though a physician is not bound to treat each and every person asking his services, he should not only be ever

ready to respond to the calls of the sick and the injured, but should be mindful of the high character of his mission and the responsibility he discharges in the course of his professional duties. In his treatment, he should never forget that the health and the lives of those entrusted to his care depend on his skill and attention. A physician should endeavour to add to the comfort of the sick by making his visits at the hour indicated to the patients. A physician advising a patient to seek service of another physician is acceptable, however, in case of emergency a physician must treat the patient. No physician shall arbitrarily refuse treatment to a patient. However, for good reason, when a patient is suffering from an ailment which is not within the range of experience of the treating physician, the physician may refuse treatment and refer the patient to another physician.

- 2.1.2 Medical practitioner having any incapacity detrimental to the patient or which can affect his performance vis-à-vis the patient is not permitted to practice his profession.

2.2 Patience, delicacy and secrecy: Patience and delicacy should characterise the physician. Confidence concerning individual or domestic life entrusted by patients to a physician and defects in the disposition or character of patients observed during medical attendance should never be revealed unless their revelation is required by the laws of the State. Sometimes, however, a physician must determine whether his duty to society requires him to employ knowledge, obtained through confidence as a physician, to protect a healthy person against a communicable disease to which he is about to be exposed.

In such instance, the physician should act, as he would wish another to act toward one of his own family in like circumstances.

- 2.3 **Prognosis:** The physician should neither exaggerate nor minimise the gravity of a patient's condition. He should ensure himself that the patient, his relatives or his responsible friends have such knowledge of the patient's condition as will serve in the best interests of the patient and the family.
- 2.4 **The patient must not be neglected:** A physician is free to choose whom he will serve. He should, however, respond to any request for his assistance in an emergency. Once having undertaken a case, the physician should not neglect the patient, nor should he withdraw from the case without giving adequate notice to the patient and his family. Provisionally or fully registered medical practitioner shall not wilfully commit an act of negligence that may deprive his patient or patients from necessary medical care.
- 2.5 **Engagement for an obstetric case:** When a physician who has been engaged to attend an obstetric case is absent and another is sent for and delivery accomplished, the acting physician is entitled to his professional fees, but should secure the patient's consent to resign on the arrival of the physician engaged.

CHAPTER 3

3. Duties of Physician in Consultation

3.1 Unnecessary consultations should be avoided:

- 3.1.1 However, in case of serious illness and in doubtful or difficult conditions, the physician should request consultation, but under any circumstances such consultation should be justifiable and in

- the interest of the patient only and not for any other consideration.
- 3.1.2 Consulting pathologists/radiologists or asking for any other diagnostic Lab investigation should be done judiciously and not in a routine manner.
- 3.2 **Consultation for patient's benefit:** In every consultation, the benefit to the patient is of foremost importance. All physicians engaged in the case should be frank with the patient and his attendants.
- 3.3 **Punctuality in consultation:** Utmost punctuality should be observed by a physician in making themselves available for consultations.
- 3.4 **Statement to patient after consultation:**
- 3.4.1 All statements to the patient or his representatives should take place in the presence of the consulting physicians, except as otherwise agreed. The disclosure of the opinion to the patient or his relatives or friends shall rest with the medical attendant.
- 3.4.2. Differences of opinion should not be divulged unnecessarily but when there is irreconcilable difference of opinion the circumstances should be frankly and impartially explained to the patient or his relatives or friends. It would be opened to them to seek further advice if they so desire.
- 3.5 **Treatment after consultation:** No decision should restrain the attending physician from making such subsequent variations in the treatment if any unexpected change occurs, but at the next consultation reasons for the variations should be discussed/explained. The same privilege, with its obligations, belongs to the consultant when sent for in an emergency during the absence of attending physician. The attending physician may prescribe medicine at any time for the patient, whereas the consultant may prescribe only in case of emergency or as an expert when called for.
- 3.6 **Patients referred to specialists:** When a patient is referred to a specialist by the attending physician, a case summary of the patient should be given to the specialist, who should communicate his opinion in writing to the attending physician.
- 3.7 **Fees and other charges:**
- 3.7.1 A physician shall clearly display his fees and other charges on the board of his chamber and/or the hospitals he is visiting. Prescription should also make clear if the physician himself dispensed any medicine.
- 3.7.2. A physician shall write his name and designation in full along with registration particulars in his prescription letterhead.
- Note:** In government hospital where the patient-load is heavy, the name of the prescribing doctor must be written below his/her signature.

CHAPTER 4

4. Responsibilities of Physicians to Each Other

- 4.1 **Dependence of physicians on each other:** A physician should consider it as a pleasure and privilege to render gratuitous service to all physicians and their immediate family dependants.
- 4.2 **Conduct in consultation:** In consultations, no insincerity, rivalry or envy should be indulged in. All due respect should be observed towards the physician in-charge of the case and no statement or remark be made, which would impair the confidence reposed in him. For this purpose no

discussion should be carried on in the presence of the patient or his representatives.

- 4.3 **Consultant not to take charge of the case:** When a physician has been called for consultation, the Consultant should normally not take charge of the case, especially on the solicitation of the patient or friends. The Consultant shall not criticise the referring physician. He/she shall discuss the diagnosis treatment plan with the referring physician.
- 4.4 **Appointment of substitute:** Whenever a physician requests another physician to attend his patients during his temporary absence from his practice, professional courtesy requires the acceptance of such appointment only when he has the capacity to discharge the additional responsibility along with his/her other duties. The physician acting under such an appointment should give the utmost consideration to the interests and reputation of the absent physician and all such patients should be restored to the care of the latter upon his/her return.
- 4.5 **Visiting another physician's cases:** When it becomes the duty of a physician occupying an official position to see and report upon an illness or injury, he should communicate to the physician in attendance so as to give him an option of being present. The medical officer/physician occupying an official position should avoid remarks upon the diagnosis or the treatment that has been adopted.

CHAPTER 5

5. Duties of Physician to the Public and to the Paramedical Profession

- 5.1 **Physicians as citizens:** Physicians, as good citizens, possessed of special training should disseminate advice on public health issues.

They should play their part in enforcing the laws of the community and in sustaining the institutions that advance the interest of humanity. They should particularly cooperate with the authorities in the administration of sanitary/public health laws and regulations.

- 5.2 **Public and community health:** Physicians, especially those engaged in public health work, should enlighten the public concerning quarantine regulations and measures for the prevention of epidemic and communicable diseases. At all times, the physician should notify the constituted public health authorities of every case of communicable disease under his care, in accordance with the laws, rules and regulations of the health authorities. When an epidemic occurs a physician should not abandon his duty for fear of contracting the disease himself.
- 5.3 **Pharmacists/Nurses:** Physicians should recognise and promote the practice of different paramedical services such as, pharmacy and nursing as professions and should seek their cooperation wherever required.

CHAPTER 6

6. Unethical Acts

A physician shall not aid or abet or commit any of the following acts which shall be constructed as unethical:

- 6.1 **Advertising:**
- 6.1.1 Soliciting patients directly or indirectly, by a physician, by a group of physicians or by institutions and organisations is unethical. A physician shall not make use of him/her (or his/her name) as subject of any form or manner of advertising or publicity through any

mode either alone or in conjunction with others which is of such a character as to invite attention to him or to his professional position, skill, qualification, achievements, attainments, specialities, appointments, associations, affiliations or honours and/or of such character as would ordinarily result in his self-aggrandisement. A physician shall not give to any person, whether for compensation or otherwise, any approval, recommendation, endorsement, certificate, report or statement with respect of any drug, medicine, nostrum, remedy, surgical, or therapeutic article, apparatus or appliance or any commercial product or article with respect of any property, quality or use thereof or any test, demonstration or trial thereof, for use in connection with his name, signature, or photograph in any form or manner of advertising through any mode nor shall he boast of cases, operations, cures or remedies or permit the publication of report thereof through any mode. A medical practitioner is, however, permitted to make a formal announcement in press regarding the following:

1. On starting practice.
 2. On change of type of practice.
 3. On changing address.
 4. On temporary absence from duty.
 5. On resumption of another practice.
 6. On succeeding to another practice.
 7. Public declaration of charges.
- 6.1.2 Printing of self-photograph, or any such material of publicity in the letterhead or an signboard of the consulting room or any such clinical establishment shall be regarded as acts of self-advertisement and unethical conduct on the part of the physician. However, printing of

sketches, diagrams, picture of human system shall not be treated as unethical.

- 6.2 **Patent and copyright:** A physician may patent surgical instruments, appliances and medicine or copyright applications, methods and procedures. However, it shall be unethical if the benefits of such patents or copyrights are not made available in situations where the interest of large population is involved.
- 6.3 **Running an open shop (dispensing of drugs and appliances by physicians):** A physician should not run an open shop for sale of medicine for dispensing prescriptions prescribed by doctors other than himself or for sale of medical or surgical appliances. It is not unethical for a physician to prescribe or supply drugs, remedies or appliances as long as there is no exploitation of the patient. Drugs prescribed by a physician or brought from the market for a patient should explicitly state the proprietary formulas as well as generic name of the drug.
- 6.4 **Rebates and commission:**
- 6.4.1 A physician shall not give, solicit, or receive nor shall he offer to give solicit or receive, any gift, gratuity, commission or bonus in consideration of or return for the referring, recommending or procuring of any patient for medical, surgical or other treatment. A physician shall not directly or indirectly, participate in or be a party to act of division, transference, assignment, subordination, rebating, splitting or refunding of any fee for medical, surgical or other treatment.
- 6.4.2 Provisions of Para 6.4.1 shall apply with equal force to the referring, recommending or procuring by a physician or any person, specimen or material for diagnostic purposes or other study/work. Nothing in this section,

however, shall prohibit payment of salaries by a qualified physician to other duly qualified person rendering medical care under his supervision.

- 6.5 **Secret remedies:** Prescribing or dispensing by a physician of secret remedial agents of which he does not know the composition, or the manufacture or promotion of their use is unethical and as such prohibited. All the drugs prescribed by a physician should always carry a proprietary formula and clear name.
- 6.6 **Human rights:** The physician shall not aid or abet torture nor shall he be a party to either infliction of mental or physical trauma or concealment of torture inflicted by some other person or agency in clear violation of human rights.
- 6.7 **Euthanasia:** Practising euthanasia shall constitute unethical conduct. However, on specific occasion, the question of withdrawing supporting devices to sustain cardiopulmonary function even after brain death, shall be decided only by a team of doctors and not merely by the treating physician alone. A team of doctors shall declare withdrawal of support system. Such team shall consist of the doctor in charge of the patient, Chief Medical Officer/Medical Officer in charge of the hospital and doctor nominated by the in-charge of the hospital from the hospital staff or in accordance with the provisions of the Transplantation of Human Organ Act, 1994.

CHAPTER 7

7. Misconduct

The following acts of commission or omission on the part of a physician shall constitute professional misconduct rendering him/her liable for disciplinary action:

- 7.1 **Violation of the regulations:** If he/she commits any violation of these Regulations.
- 7.2 If he/she does not maintain the medical records of his/her indoor patients for a period of three years as per Regulation 1.3 and refuses to provide the same within 72 hours when the patient or his/her authorised representative makes a request for it as per the Regulation 1.3.2.
- 7.3 If he/she does not display the registration number accorded to him/her by the State Medical Council or the Medical Council of India in his clinic, prescriptions and certificates, etc., issued by him or violates the provisions of Regulation 1.4.2.
- 7.4 **Adultery or improper conduct:** Abuse of professional position by committing adultery or improper conduct with a patient or by maintaining an improper association with a patient will render a Physician liable for disciplinary action as provided under the Indian Medical Council Act, 1956 or the concerned State Medical Council Act.
- 7.5 **Conviction by Court of Law:** Conviction by a Court of Law for offences involving Moral Turpitude/Criminal Acts.
- 7.6 **Sex determination tests:** On no account sex determination test shall be undertaken with the intent to terminate the life of a female foetus developing in her mother's womb, unless there are other absolute indications for termination of pregnancy as specified in the Medical Termination of Pregnancy Act, 1971. Any act of termination of pregnancy of normal female foetus amounting to female foeticide shall be regarded as professional misconduct on the part of the physician leading to penal erasure besides rendering him liable to criminal proceedings as per the provisions of this Act.
- 7.7 **Signing professional certificates, reports and other documents:** Registered medical practitioners are in certain cases bound by law to give, or may from time to time be

called upon or requested to give certificates, notification, reports and other documents of similar character signed by them in their professional capacity for subsequent use in the courts or for administrative purposes, etc. Such documents, among others, include the ones given at Appendix-4. Any registered practitioner who is shown to have signed or given under his name and authority any such certificate, notification, report or document of a similar character which is untrue, misleading or improper, is liable to have his name deleted from the register.

- 7.8 A registered medical practitioner shall not contravene the provisions of the Drugs and Cosmetics Act and Regulations made thereunder. Accordingly:
- (a) prescribing steroids/psychotropic drugs when there is no absolute medical indication;
 - (b) selling Schedule 'H' & 'L' drugs and poisons to the public except to his patient.

In contravention of the above provisions shall constitute gross professional misconduct on the part of the physician.

- 7.9 Performing or enabling unqualified person to perform an abortion or any illegal operation for which there is no medical, surgical or psychological indication.
- 7.10 A registered medical practitioner shall not issue certificates of efficiency in modern medicine to unqualified or non-medical person.

Note: The foregoing does not restrict the proper training and instruction of bonafide students, midwives, dispensers, surgical attendants, or skilled mechanical and technical assistants and therapy assistants under the personal supervision of physicians.

- 7.11 A physician should not contribute to the lay press articles and give interviews regarding

diseases and treatments which may have the effect of advertising himself or soliciting practices; but is open to write to the lay press under his own name on matters of public health, hygienic living or to deliver public lectures, give talks on the radio/TV/ internet chat for the same purpose and send announcement of the same to lay press.

- 7.12. An institution run by a physician for a particular purpose such as a maternity home, nursing home, private hospital, rehabilitation centre or any type of training institution, etc., may be advertised in the lay press, but such advertisements should not contain anything more than the name of the institution, type of patients admitted, type of training and other facilities offered and the fees.
- 7.13 It is improper for a physician to use an unusually large sign board and write on it anything other than his name, qualifications obtained from a university or a statutory body, titles and name of his speciality, registration number including the name of the State Medical Council under which registered. The same should be the contents of his prescription papers. It is improper to affix a signboard on a chemist's shop or in places where he does not reside or work.
- 7.14 The registered medical practitioner shall not disclose the secrets of a patient that have been learnt in the exercise of his/her profession except:
- (i) in a court of law under order of the Presiding Judge;
 - (ii) in circumstances where there is a serious and identified risk to a specific person and/or community; and
 - (iii) notifiable diseases. In case of communicable/notifiable diseases, concerned public health authorities should be informed immediately.
- 7.15 The registered medical practitioner shall not refuse on religious grounds alone to give

- assistance in or conduct of sterility, birth control, circumcision and medical termination of pregnancy when there is medical indication, unless the medical practitioner feels himself/herself incompetent to do so.
- 7.16 Before performing an operation the physician should obtain in writing the consent from the husband or wife, parent or guardian in the case of minor, or the patient himself as the case may be. In an operation which may result in sterility the consent of both husband and wife is needed.
- 7.17 A registered medical practitioner shall not publish photographs or case reports of his/her patients without their permission, in any medical or other journal in a manner by which their identity could be made out. If the identity is not to be disclosed, the consent is not needed.
- 7.18 In the case of running a nursing home by a physician and employing assistants to help him/her, the ultimate responsibility rests on the physician.
- 7.19 A physician shall not use touts or agents for procuring patients.
- 7.20 A physician shall not claim to be specialist unless he has a special qualification in that branch.
- 7.21 No act of *in vitro* fertilisation or artificial insemination shall be undertaken without the informed consent of the female patient and her spouse as well as the donor. Such consent shall be obtained in writing only after the patient is provided, at her own level of comprehension, with sufficient information about the purpose, methods, risks, inconveniences, disappointments of the procedure and possible risks and hazards.
- 7.22 Research: Clinical drug trials or other research involving patients or volunteers as per the guidelines of ICMR can be undertaken, provided ethical considerations are borne in mind. Violation of existing ICMR guidelines in this regard shall constitute misconduct. Consent taken from the patient for trial of drug or therapy which is not as per the guidelines shall also be construed as misconduct.
- 7.23 If a physician posted in rural area is found absent on more than two occasions during inspection by the Head of the District Health Authority or the Chairman, Zila Parishad, the same shall be construed as a misconduct if it is recommended to the Medical Council of India/State Medical Council by the State Government for action under these Regulations.
- 7.24 If a physician posted in a medical college/institution both as teaching faculty or otherwise shall remain in hospital/college during the assigned duty hours. If they are found absent on more than two occasions during this period, the same shall be construed as a misconduct if it is certified by the Principal/Medical Superintendent and forwarded through the State Government to Medical Council of India/State Medical Council for action under these Regulations.

CHAPTER 8

8. Punishment and Disciplinary Action

- 8.1 It must be clearly understood that the instances of offences and of professional misconduct which are given above do not constitute and are not intended to constitute a complete list of the infamous acts which calls for disciplinary action, and that by issuing this notice the Medical Council of India and/or State medical Councils are in no way precluded from considering and dealing with any other form of professional misconduct on the part of a registered practitioner. Circumstances may and do

arise from time to time in relation to which there may occur questions of professional misconduct which do not come within any of these categories. Every care should be taken that the code is not violated in letter or spirit. In such instances as in all others, the Medical Council of India and/or State Medical Councils have to consider and decide upon the facts brought before the Medical Council of India and/or State Medical Councils.

- 8.2 It is made clear that any complaint with regard to professional misconduct can be brought before the appropriate Medical Council for disciplinary action. Upon receipt of any complaint of professional misconduct, the appropriate Medical Council would hold an enquiry and give opportunity to the registered medical practitioner to be heard in person or by pleader. If the medical practitioner is found to be guilty of committing professional misconduct, the appropriate Medical Council may award such punishment as deemed necessary or may direct the removal altogether or for a specified period, from the register of the name of the delinquent registered practitioner. Deletion from the Register shall be widely publicised in local press as well as in the publications of different Medical Associations/Societies/Bodies.
- 8.3 In case the punishment of removal from the register is for a limited period, the appropriate Council may also direct that the name so removed shall be restored in the Register after the expiry of the period for which the name was ordered to be removed.
- 8.4 Decision on complaint against delinquent physician shall be taken within a time limit of six months.
- 8.5 During the pendency of the complaint the appropriate Council may restrain the physician from performing the procedure or practice which is under scrutiny.

- 8.6. Professional incompetence shall be judged by peer group as per guidelines prescribed by Medical Council of India.

APPENDIX-1

A. Declaration

At the time of registration, each applicant shall be given a copy of the following declaration by the Registrar concerned and the applicant shall read and agree to abide by the same:

- 1. I solemnly pledge myself to consecrate my life to the service of humanity.
- 2. Even under threat, I will not use my medical knowledge contrary to the laws of humanity.
- 3. I will maintain utmost respect for human life from the time of conception.
- 4. I will not permit considerations of religion, nationality, race, party politics or social standing to intervene between my duty and my patient.
- 5. I will practise my profession with conscience and dignity.
- 6. The health of my patient will be my first consideration.
- 7. I will respect the secrets which are confined in me.
- 8. I will give to my teachers the respect and gratitude which is their due.
- 9. I will maintain by all means in my power, the honour and noble traditions of medical profession.
- 10. I will treat my colleagues with all respect and dignity.
- 11. I shall abide by the code of medical ethics as enunciated in the Indian Medical Council (Professional Conduct, Etiquette and Ethics) Regulations 2002.

I make these promises solemnly, freely and upon my honour.

Signature.....
 Name.....
 Place.....

Address.....
Date.....

APPENDIX-2

1. Form of Certificate Recommended for Leave or Extension or Communication of Leave and for Fitness

Signature of patient
Or thumb impression.....
To be filled in by the applicant in the presence of the Government Medical Attendant, or Medical Practitioner.
Identification marks:
1.....
2.....

I, Dr..... after careful examination of the case certify hereby that.....whose signature is given above is suffering from.....and I consider that a period of absence from duty ofwith effect fromis absolutely necessary for the restoration of his health.

I, Dr.....after careful examination of the case certify hereby that.....on restoration of health is now fit to join service.

Place..... Signature of medical attendant.
Date..... Registration No.
(Medical Council of India/State Medical Council ofState)

Note: The nature and probable duration of the illness should also be specified. This certificate must be accompanied by a brief resume of the case giving the nature of the illness, its symptoms, causes and duration.

APPENDIX-3

Format for Medical Record

(see Regulation 3.1)
Name of the patient :
Age :
Sex :
Address :
Occupation :
Date of 1st visit :
Clinical note (summary) of the case :
Prov.: Diagnosis :
Investigations advised with reports :
Diagnosis after investigation :
Advice :
Follow up :
Observations :
Date
Signature in full.....
Name of Treating Physician

APPENDIX-4

List of Certificates, Reports, Notifications, etc. Issued by Doctors for the Purposes of Various Acts/Administrative Requirements

- (a) Under the Acts relating to Birth, Death or Disposal of the Dead.
- (b) Under the Acts relating to Lunacy and Mental Deficiency and under the Mental Illness Act and the Rules made thereunder.
- (c) Under the Vaccination Acts and the Regulations made thereunder.
- (d) Under the Factory Acts and the Regulations made thereunder.
- (e) Under the Education Acts.

- (f) Under the Public Health Acts and the orders made thereunder.
- (g) Under the Workmen's Compensation Act and persons under Disability Act.
- (h) Under the Acts and Orders relating to the notification of infectious diseases.
- (i) Under the Employee's State Insurance Act.
- (j) In connection with sick benefit insurance and friendly societies.
- (k) Under the Merchant Shipping Act.
- (l) For procuring/issuing of passports.
- (m) For excusing attendance in courts of justice, in public services, in public offices or in ordinary employment.
- (n) In connection with Civil and Military matters.
- (o) In connection with matters under the control of Department of Pensions.
- (p) In connection with quarantine rules.
- (q) For Procuring Driving Licence.

The ICMR code defines that research on human subjects should be with the purpose to increase knowledge and should be conducted in a proper manner. Informed consent should be taken. While conducting research, exploitation should not be done and proper safety methods for the health of human subject should be taken. ICMR code provides for establishment of IEC (Institutional Ethics Committee) to supervise and regulate research in a research institute. The confidentiality of patients should be maintained. Specific principles of clinical evaluation of drugs/ vaccines/ devices/diagnostics/herbal remedies have been described in detail. Specific principles for epidemiological studies have been dealt with in detail. Guidelines of human genetic research have also been detailed. Other specific principles included are for research in transplantation including foetal tissue transplantation. Creation of human being for transplantation purposes is banned.

ETHICAL GUIDELINES FOR BIOMEDICAL RESEARCH ON HUMAN SUBJECT—ICMR CODE

Indian Council of Medical Research has prescribed general principles in biomedical research on human subjects, commonly known as ICMR code to be followed by all scientists working in India. It is binding on all scientists and action can be taken if someone violates it. It consists of following:

1. Statement of general principles on research using human subjects in biomedical research.
2. Statement of specific principles on research using human subjects in specific areas of biomedical research.

USE OF RED CROSS EMBLEM

It has been seen that all over India, anyone who is associated with health services uses the Red Cross emblem. This may not be unethical but it is illegal. As per the Geneva Convention Act 1960 to which India is a signatory, Section 12 prohibits the use of Red Cross emblem and all other allied emblems for any purpose whatsoever, without approval from the Government of India. Only members of medical division of armed forces of a country are authorised to use Red Cross emblem (a red cross on a white background). I think the Government of India should issue clear guidelines in this regard to stop its misuse as it is misused by chemists, paramedical staff and all hospital employees all over India.

CHAPTER 26

Law in Relation to Medical Practice: Part II

MEDICAL NEGLIGENCE

Medical negligence was previously called malpractice. Although both words are synonyms but they do not mean the same. Malpractice includes other forms of irregular medical practice. Majority of the cases of medical negligence are civil in nature while some of them may amount to be criminal in nature.

Medical negligence is defined as breach of duty owed by a doctor to his patient to exercise reasonable degree of skill and care.

For medical negligence to be proved, the following must be there:

- The doctor owed a duty of care to the patient.
- There was a breach of the duty.
- The patient suffered a damage.

Doctor-patient Relationship

Once a doctor-patient relationship has been established, doctor cannot take the plea of not owning the duty of care. It is immaterial whether professional fee has been paid or not. The moment the patient enters the clinic of the doctor and doctor starts examining the patient, the duty begins. Even in charitable hospitals where no money is charged, a doctor can be charged of medical negligence. Not charging a professional fee does not protect the doctor from criminal negligence.

Duty to Exercise Reasonable Degree of Skill and Care

It is expected of the doctor that once he has obtained requisite qualification, he is expected to acquire skill to treat the patient and exercise good care. Degree of skill and care is not defined but it is assumed that he will exercise reasonable degree of skill and care. He may not be the best in the community of doctors but it is assumed that he is average and his expertise should be at least average in his peer group. It is also understood that a doctor may not always be knowing the latest in his field but it is expected that he is aware of new techniques that are coming to his specialty. A doctor is not liable if there is any error of judgement in diagnosis or treatment.

Damage Suffered by a Patient

A patient can charge the doctor only if he has suffered damage. If no damage has occurred, no case of negligence can be made. Damages are of the following kinds:

1. **Loss of Earnings:** It may be due to enforced medical rest or temporary/ permanent impairment of his ability to carry out his occupation. It may be possible that the patient he might have to change the nature of his job or profession which may reduce his earnings.

2. **Expenses:** Patient may claim that he has paid more to the doctor than he deserved.
 3. **Reduction in Expectation of Life.**
 4. **Reduced Pleasure of Life:** This may occur due to psychic reasons or physical disability caused by the doctor during treatment, e.g. loss of sexual pleasure due to negligent surgery of penis or vagina.
 5. **Physical or Mental Suffering.**
 6. **Death:** Patient's relative may claim that due to negligent action of the doctor, the patient has died.
2. Failure to do suction in the case of unconscious patient may cause aspiration.
 3. Failure to monitor foetal heart rate can cause foetal death.
 4. Failure in resuscitation may cause death.

Act of Commission

If a patient suffers damages due to direct effect of treatment, it amounts to an act of commission. There are certain situations where the doctrine of *res ipsa loquitar* is applied, which means 'it speaks for itself'. The following are the examples:

1. Presence of operative instrument in the abdomen/chest.
2. Operation on wrong limb/eye.
3. Wrong or fatal dosages of drugs/anaesthetic agents.

To prove the doctrine of *res ipsa loquitar*, the following components should be there:

- The damage/injury could not have been produced without treatment taken.
- Patient has not contributed to negligence.
- Doctor was in exclusive control of circumstances.

Types of Medical Negligence

They are of the following two types:

1. **Civil Negligence:** When a patient demands monetary compensation for the damage suffered, it is called civil medical negligence. For this, the patient can approach civil court or consumer redressal forum.
2. **Criminal Negligence:** When a patient or his relative approaches the police to take action against the doctor for the damages he has caused to him, it is called criminal negligence.

In death cases, most of the cases are registered against the doctor in Section 304A of the I.P.C. Sometimes, cases are also registered under Sections 325 and 302 of the I.P.C.

How can the Negligence be Caused?

The damages to the patient can be caused by act of Omission and act of Commission.

Act of Omission

Failure to exercise reasonable degree of care can cause damage to the patient. The following examples may illustrate the acts of omission:

1. Failure to give proper post-operative care may result in death/damage due to sudden fall of blood pressure, cardiac arrest, etc.

Contributory Negligence

When a patient contributes toward negligence, it is called contributory negligence. In this, both doctor and patient contribute toward negligence suffered by the patient. Common examples of contributory negligence are given below:

1. When a patient does not give proper history of anaphylaxis/drug reaction on being asked by the doctor and later he suffers damages due to this on the prescription of such drug.
2. Failure to take medicines as prescribed by the doctor may cause brain haemorrhage in a hypertensive subject.
3. Early movements in a case of fracture may cause re-fracture.

- Wrong medication in wrong dosages taken by the patient himself may cause damages. Contributory negligence is a good plea for the doctor in a case of negligence. But burden of proving contributory negligence lies on the doctor himself.

vials. But hospital can also be held responsible if it is seen that hospital has not taken adequate steps for repair/ maintenance of such instrument. Hospital can also be sued if proper maintenance of drug vials is not followed.

Corporate Negligence

It is possible that the damage suffered by the patient may be due to hospital/nursing home where he is receiving treatment. In such cases, the doctor has no role to play. The following examples may be there:

- Patient may fall from stairs due to defective steps and may sustain injuries.
- Patient may fall from stretcher/wheel chair due to fault in the carrier.
- Patient's care is affected as a result of inadequate number of nurses/paramedical staff.
- Hospital may not have sufficient infrastructure to manage the patient and hence patient suffered damages.

Products Liability

Sometimes, patient can get damages as a result of faulty instruments, faulty injection set or use of inadequate drugs. In such cases, doctor who is using such instruments or drugs may not be aware that they are faulty.

Examples of this nature are:

- Patient may get electrocuted while cautery is being done.
- Patient may get severe burns because of leakage of hot water from hot packs.
- Injection vial containing the desired drug may not have proper drug or proper concentration.
- Suction apparatus may not be working properly. In all such cases, the liability of negligence would lie on companies manufacturing such instrument or the drug

Novus Actus Interveniens

(Latin: 'a new intervening act')

Rarely it is reported that damages have occurred due to a new action which intervenes the treatment. In such cases, the concerned doctor is not held responsible, as he had no control over the circumstances. The unexpected unforeseen circumstances must not have been thought of by the doctor. The following are its examples:

- A patient who is in a condition of shock is being operated and suddenly due to earthquake, a piece of ceiling falls over the patient and he dies.
- An ambulance carrying a serious patient may get involved in road traffic accident and the patient may die.

Vicarious Responsibility

It means responsibility of respondeat superior (Latin: 'let the superior reply'). In this, liability for negligence lies on the master or employer. In law, the master is held responsible for the negligent acts of his servants within the scope of employment but is not liable if he has employed an independent person to do something. Accordingly, hospitals are liable for the negligent actions of its paramedical staff and full-time junior medical staff. Hospital is not responsible for the negligent actions of honorary consultants as they do not come under purview of employment.

Comparative Negligence

It is a new concept in medical negligence especially involving contributory negligence. In this, it is seen that how much a patient has contributed to negligence and damages are awarded keeping in

view the patient's role. In such cases, the quantum of award would depend upon the ratio of the doctor's and the patient's negligence. If both have contributed 50 per cent each, no compensation may be awarded.

Defence Against an Allegation of Negligence

The following may be considered as three possible avenues for defence:

1. **Delegation of Duties:** In this case, the doctor who is sued takes the plea that negligence that occurred was not due to him but by others whom he has delegated duty like anaesthetist, surgeon, etc. It is sometimes difficult for the patient to know whom to sue, and in these cases the onus of refutation would fall on all concerned.
 2. **Contributory Negligence:** The doctor can take the defence of contributory negligence but in law, he has to prove that the patient has contributed toward negligence. It is quite difficult. But if he can show some amount of contribution by the patient, he might have to pay less compensation.
 3. **Consent of the Patient:** It may be contested that the patient has willingly assumed the risk of events actually taking place. This is called doctrine of *volenti non fit injuria*. It is best described in sports like boxing, motor racing, etc., where if any damage occurs, there can be no claim. The same principle is applied in medical treatment where doctor can take plea that incidence of expected injuries was explained to the patient and he has willingly taken the risk. This is a good defence if the patient has refused to take completely full course of the treatment. Proof of refusal by the patient should be obtained in writing if possible, otherwise such a remark must be made in case sheets.
1. Always obtain informed consent in writing.
 2. Always keep a file of laws related to medical practice in office.
 3. Employ only qualified assistants.
 4. Have routine checking of all instruments for proper functioning and wiring.
 5. Do not keep technical medical literature within the reach of the patients. Misunderstanding can occur through misinterpretation.
 6. Do not give any diagnosis on telephone.
 7. Do not prescribe medicine without examination of the patient.
 8. Do not ever guarantee results.
 9. Keep everything confidential and do not show medical records to anyone without the patient's permission.
 10. Never abandon your patient.
 11. Do not argue over charges. Settle it amicably. If patient does not pay, if possible, forget it.
 12. Have sympathy with the patient. Accept the patient as a 'whole'.
 13. Do not lie, threaten or commit fraud in your relationship with the patient.
 14. Do not criticise any patient or your colleague in the presence of other patients.
 15. Medico-legal cases should not be refused treatment.
 16. The most important is to talk to the patient and his relatives. Never assume that patient knows it.

CONSUMER PROTECTION ACT

Consumer Protection Act, 1986 was introduced with the purpose to provide relief to the consumer against erring traders and manufacturers. It was envisaged at that time that there is a need of protection of consumer from wrong business practices. The Act was intended to provide cheap and speedy trial for consumer benefit, as it was found that civil courts are already burdened with heavy work and thus unable to provide speedy justice.

Law defines the obligations of manufacturers and traders. Any consumer who feels that the

Guidelines to Avoid Negligence Suites

Negligence suites can be avoided by following the below mentioned guidelines:

service is not provided to him for which he has paid is entitled for relief.

Under the Act, Forums have been established at district level, state level and national level.

1. **District Forum (Consumer Forum):** In every district of the country, district forums are created. The district forum has three members. The Chairman is either a sitting district and session judge or a retired one. Others are two eminent citizens, one being a lady. The district forum can award a compensation of up to Rs. 20 lakhs.
2. **State Level Forum:** Commonly called the State Consumer Redressal Commission, it has been set up at state level. It is presided over by a sitting High Court judge or a retired one. Others are two prominent citizens, one being a lady member. Appeals against the judgements of the District Consumer Forum are heard in the State Consumer Redressal Commission. The state commission can award compensation of up to Rs. One crore.
3. **National Level Forum:** In New Delhi, there is a National Consumer Redressal Commission which is presided over by a sitting Supreme Court judge or a retired one. Other members are prominent citizens, one being a lady member. Appeals against judgements of the State Consumer Redressal Commissions are heard in this forum. The commission can award any amount of compensation. Appeal against the judgements of the National Consumer Redressal Commission can be filed only in the Supreme Court.

Procedure of Filing a Complaint

The procedure of filing a complaint against a deficiency of service by a trader is very simple. There is no need of a lawyer. No court fee is required. Application on a plain paper is sufficient along with a copy of the goods purchased. It was envisaged at that time that judgement would be

given in 90 days, but now even in consumer forums there is a lot of pendency which results in inordinate delay.

The complaint has to be filed within 2 years of the cause of action. But the court has the power to admit the case even after 2 years if it finds reasons of delay condonable.

The Act allows provisions for establishing consumer protection councils at state and central level working for the promotion and protection of the rights of the consumer.

Consumer Protection Act and Medical Profession

Initially, medical profession was not included in the ambit of Consumer Protection Act as it was thought that medical care is not covered under concept of 'service'. It was also thought that since the behaviour of the body is unpredictable even in the best of circumstances, common risks of medical profession can be misinterpreted and challenged unnecessarily.

On 13.11.1995, the Supreme Court of India in its judgement in Civil Appeal No. 688 of 1993 in a case of Indian Medical Association vs V.P. Shantha & others held that medical practitioner can be sued for compensation under Consumer Protection Act, 1986 for any act of negligence. The Court held that services rendered by doctors and hospitals are covered in the "service" as defined under Section 2(1)(0) of the Consumer Protection Act, 1986.

Following are the salient features of the judgement.

1. Hospitals and doctors which render service without any charge whatsoever to every person availing the service would not fall under the purview of "service."
2. If a hospital is charging a token amount for registration but providing free services to everyone, it would not be covered under the Act.
3. Services rendered by doctors and hospitals or nursing homes on payment basis fall under the ambit of the Act.

4. Doctors and hospitals or nursing homes which provide free service to some of the patients belonging to poor class but the bulk of the service is rendered to the patient on payment basis are also covered under the Act.
5. When a person has taken an insurance policy for medical treatment whereunder all the charges for consultations, diagnosis and medical treatment are borne by an insurance company, a person receiving the treatment is beneficiary of the service which has been rendered by medical practitioner, the payment for which would be met by insurance company under the insurance policy. The service rendered to him by the medical practitioner would not be free of charge and would, therefore, constitute service as defined in the Act.
6. Government hospitals/dispensaries where services are rendered on payment of charges and also rendered free of charges to other persons availing such services would fall under the ambit of the Act.
7. Services rendered free in government hospitals/dispensaries will not be covered within the ambit of the Act. Therefore, such government doctors/hospitals or dispensaries would be outside the purview of consumer forum. However, the services paid for, like pathological, radiological and other diagnostic procedures for which a fee is charged by the hospital will fall within the ambit of this Act.
8. Services rendered at AIIMS, New Delhi; PGIMER, Chandigarh, etc., which are being paid for, are also covered within the ambit of the Act.

Post-inclusion Scenario of Medical Profession in Consumer Protection Act, 1986

After inclusion of medical profession, a lot of hue and cry was raised, but slowly doctors are realising that it may be beneficial in the long run. As patients

are now more aware of their rights, they would also be in a position to understand doctors' viewpoint. The Act would also help in curbing the activities of quacks or pseudo-doctors. It is hoped that it would bring more control over substandard care and substandard instruments. It will result in the enhancement of levels of patient care. It would make doctors more responsive to their patients.

Some feel otherwise. They think it would increase the cost of medical treatment as doctors would go for defensive medicine and thus would opt for more and more investigations for which the patient would be paying. Some feel that doctors would hesitate in taking bold steps and would rely on conservatism.

I personally feel that by the inclusion of medical profession into the ambit of Consumer Protection Act, 1986, now there would be more trust and transparency in doctor-patient relationship. There would be an increase in the standards of medical care, which in a long run would benefit the society. Let us see how things work in future.

Medical Indemnity Insurance

It is an insurance plan offered now by various insurance companies to doctors, nursing homes, or hospitals to pay compensation to patients when legally imposed by consumer court or civil court in cases of negligence. The doctor who buys insurance plan pays premium to the insurance companies every year. The premium varies according to the specialties. Surgeons and anaesthetists have to pay more as compared to physicians as chances of litigations are higher in these two specialties.

Now certain medical defense unions have also come into force. They offer all kinds of support in case of medical negligence. It involves preparing defence, hiring lawyers to defend and liaison with insurance companies. Some medico-legal consultants are also giving professional help on charge basis in cases of medical negligence.

Recent Advances in Crime Detection

Nowadays, in the era of terrorism and high profile crime, it is essential that science keeps pace with newer methods of crimes and helps the investigating team in obtaining some vital information about the accused, suspects and informants. The following techniques are recent ones and are being used all over the world. These techniques are now available in India as well and have been adopted in many cases:

1. Polygraph or Lie Detector Test: This method was invented by Dr. John Larson, USA in 1921. It is based on the fact that there are changes in the body which occur when a person lies and these changes can be effectively documented. In this process, the subject is made to lie on a bed and a lot of sensors are attached to his body. These sensors measure changes in breathing, blood pressure, pulse, respiratory rate and sweating. During this process, the subject is asked some standard questions (also called control questions) which are correct and then his responses are recorded on a polygraph. Then actual questions are asked which are mixed with fillers and the person's response to these questions is documented. It has been generally found that if a person is lying, his blood pressure and heart rate increase along with high perspiration. The person's response to some fillers is also documented. Since all these responses are recorded on a polygraph, it is also called 'polygraph test'. Usually the subject's

examination lasts about 2 hours. This test is quite important in cases of non-habituated criminals but it fails in highly determined and highly motivated criminals as they can speak lie very easily. No permission is needed from the court to conduct this study. The findings of this test are not admissible in the court of law but can provide leads to the investigating agencies.

2. Narco-analysis or Truth Serum Test: In 1930s, a number of psychiatrists started analysing patients after giving drugs to them. This induced a state of sleep in them which decreased the effectiveness of the patients in controlling their conscious stage. The term narco-analysis was coined as the drugs were narcotics or sleep inducers.

This test is performed under the supervision of an anaesthetist and clinical psychologist. The fitness of the subject is evaluated by anaesthetist—whether drug can be administered to him or not. His physical examination is documented. Sodium pantothenol or sodium amytal, which is commonly used in hospital practice to induce anaesthesia, is administered in low doses. This drug causes sedation just like alcohol and the person becomes talkative and less inhibited. His ability to hide truth decreases. Now a set of questions are asked to him in a controlled manner. His responses are recorded via sound recorder. Most of the time, the subject is able to reveal the truth as his guilt complex decreases.

This test can be performed only with the permission of the court and the subject himself as nobody can be forced to give evidence against himself. The report of this test is not admissible in the court of law but it can provide leads to the investigating team to reach the truth. The test is controversial but has been performed in many cases in recent past.

3. Brain Mapping or Brain finger printing: In late 1980s in USA, Institute of Medicine of the National Academy of Science started evaluating the importance of integrating neuroscientific information by MRI, EEG, positron emission tomography (PET) and other non-invasive scanning techniques to map anatomy, psychology, perfusion, function and phenotypes of human brain. The brain mapping was started for study of memory, learning, aging and drug effects especially in schizophrenics, autistics and depressed people. This led to the establishment of the human brain project and later international consortium on brain mapping evolved.

Now this technique is used in crime detection also. It is based on the principle that by showing images and words associated with the case, the investigator wants to know if the subject has memories about the case. When a subject is shown an image or words associated with the case, a wave known as P300 is generated (the name is so given because the wave is generated 300 millisecond after the images or words are shown). This P300 wave can be documented. This test is non-invasive. This test was patented in 2001 by Lawrence Farwell, USA. The subject is made to sit on a chair and a band containing six to seven neurosensors is attached. First the control experiments are done. Then the subject is shown images, words or

incidents related to the case, and his responses are recorded. If a person has seen these images, P300 wave is generated. The test usually takes 5-6 hours. Permission from the court is not needed. The results are not admissible in court of law but can provide leads to the investigative agencies to solve the case. This test has been done in many cases in recent past like in Telgi case.

4. Hypnosis: Hypnosis is a trance stage induced by suggestion. In this, the subject is given commands to relax, and slowly by giving suggestions, he is taken to a deep sleep stage, where his unconscious mind can be probed. During the entire stage, the subject remains conscious. This test can be done only with the active help of the subject. This test is quite useful in investigation of cases where information is sought from persons who witnessed the crime instead of committing it. It may help them giving details about the persons who committed the crime. The report of this test is also not admissible in court of law but can provide leads to the investigators about the persons who committed the crime.

5. Writing Analysis or Graphology: ‘Graphology’ or ‘handwriting analysis’ is done to know the genuineness of documents and to create psychological profile of the person concerned. It is also used in various industries to know about an employee’s character. The report of this is admissible in court of law in many cases of forged documents.

6. Voice Stress Test: It is based on the principle that when a subject is lying, there are changes in his voice patterns which can be documented objectively. No consent of the individual is required but its report is not admissible in court of law.

FORENSIC SLIDES

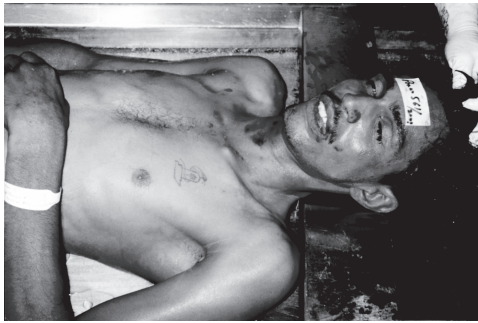


Plate 1: Note tattoo mark on the body. (Reference chapter 3)

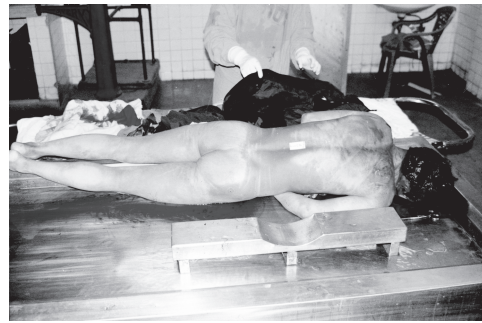


Plate 2: Post-mortem staining on body. (Reference chapter 4)

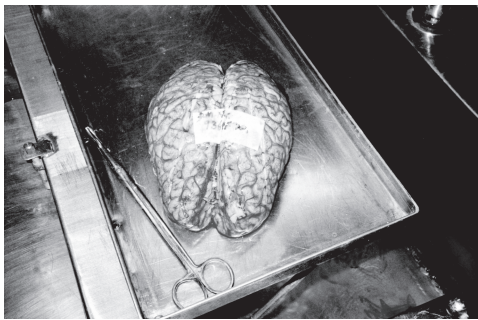


Plate 3: Normal brain after removal from skull. (Reference chapter 4)



Plate 4: Body showing putrefaction. (Reference chapter 5)

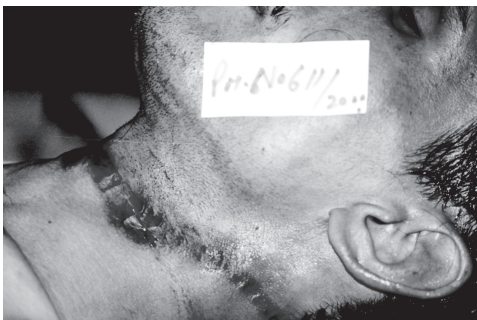


Plate 5: Strangulation mark on neck. (Reference chapter 9)

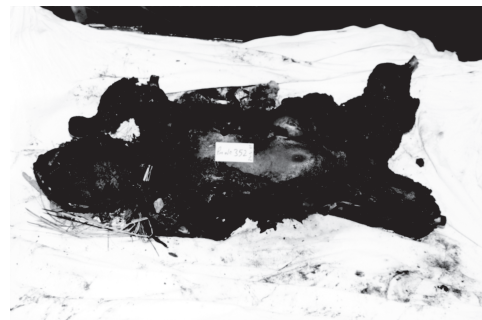


Plate 6: Charred body. (Reference chapter 11)



Plate 7: Amputation and crushing of leg due to road side accident.
(Reference chapter 12)



Plate 8: Fire-arm injury.
(Reference chapter 13)



Plate 9: Multiple abrasions on body due to roadside accident.
(Reference chapter 13)



Plate 10: Rupture of head due to road traffic accident.
(Reference chapter 16)





Section 2

TOXICOLOGY





CHAPTER 28

Medico-legal Aspects of Poisons

DEFINITION OF TOXICOLOGY

The toxicology is defined as science which deals with knowledge of source, character and properties of poisons, their symptoms in the body, their pharmacological actions and treatment.

Definition of Poison

Poison is a substance introduced in the body to produce ill-effect, disease or death. It may be of any origin like synthetic, mineral, animal or vegetable. It may be introduced through any route like mouth, nostril, anus, vagina, ears, eyes, or by injection or inhalation.

Definition of Drug

Drug is defined as any substance to be introduced in the human body for diagnosis, investigation, treatment or prevention of any disease.

LAWS RELATING TO POISONS

The following are the laws related to poisons:

1. **Narcotic Drugs and Psychotropic Substances (NDPS) Act:** This was promulgated in 1985. A narcotic drug is defined as cocoa leaves, cannabis, opium, poppy straw and all manufactured drugs. The 'manufactured drug' means all cocoa derivatives, medicinal cannabis, opium

derivatives, poppy straw concentrate and any other narcotic substance or preparation which the Central Government may include by notification in the list. A 'psychotropic substance' is defined as any substance natural or synthetic, or any preparation which is included in the list of psychotropic substance. It contains a list of 77 psychotropic substances. The Act provides severe punishment for the person possessing narcotic drugs. The Act differentiates between the user and the trafficker. It provides for less punishment for user who is in possession drugs for his own use. It views user with sympathy. To differentiate between the user and the trafficker the quantities of drugs in possession is defined differently for each drug. The offence in NDPS Act for traffickers is non-bailable and severe sentences are common.

2. **The Drug Act, 1940:** The purpose of this Act was to regulate import, manufacture, distribution and sale of drugs like patent or proprietary medicines, vaccines, sera, toxins, antitoxins, antigen, other biological products like vitamins, hormones and drugs commonly used for external or internal consumption. Later, insecticides, disinfectants and contraceptives were added. This Act was later changed to Drugs and Cosmetics Act, 1940 to include cosmetics.

The cosmetic was defined in this Act as “Any article intended to be rubbed, poured, sprinkled or sprayed on, or introduced into, or otherwise applied to, the human body or any part thereof for cleansing, beautifying, promoting attractiveness or altering the appearance, and include any article intended for use as component of cosmetics.

This Act was later amended to include Ayurvedic and Unani drugs. Under this Act, medicines are classified into Schedule H and Schedule L.

Schedule H contains list of poisons which can be sold only on prescription of a registered medical practitioner and these substances are labelled with the words “SCHEDULE ‘H’ DRUG” Warning – “To be sold by retail on the prescription of registered medical practitioner only”. Schedule L contains a list of antibiotics, antihistaminic and other chemotherapeutic agents of recent origin. These substances are also labelled as “SCHEDULE ‘L’ DRUGS” Warning “To be sold by retail on the prescription of a registered medical practitioner only.”

The prescription of a registered medical practitioner must be in writing, and signed by him with date. Name and address of the patient must be given. Total amount of medicine and dose should be clearly mentioned.

3. **Pharmacy Act, 1948:** The purpose of this act is to make better provision for the regulation of the profession of pharmacy and setting up of ‘Pharmacy Councils’. Under this act, Central Pharmacy Council was established which has control over education and examination of students entering pharmacy. The State Councils have also been constituted under this act.

MEDICO-LEGAL ASPECTS OF POISONING

Poisoning in India is quite common. There are instances of human and cattle poisoning. Cattle

poisoning is mostly intentional to kill the cattle of the neighbour. Human poisoning can be accidental, suicidal or homicidal:

1. **Accidental Poisoning:** Most of the poisoning is accidental. In children most of the poisoning is accidental as they consume tablets or syrup in the household accidentally. Accidental poisoning can occur in agricultural workers when spraying insecticides. It can occur if a person drinks unsafe water contaminated with arsenic, etc.
2. **Suicidal Poisoning:** Nowadays, suicides by poisoning is very common among farmers, especially in Andhra Pradesh and Punjab. They consume insecticides when they are unable to pay agricultural loans. Aluminium phosphide and organophosphorus compounds are first choice followed by organochloro compounds. Suicide by poisoning is also common in housewives.
3. **Homicidal Poisoning:** Poison is very commonly used for homicides, especially on young children who are done away with this easily. Arsenic is commonly used followed by opium, aconite, dhatura, strychnine and potassium cyanide. If the intention is not to kill but rob, stupefying agents like dhatura, *Cannabis indica* or chloral hydrate are used.

CLASSIFICATION OF POISONS

Poisons are classified according to the symptoms which they produce in the body. Generally, poisons are classified as follows:

Classification 1: Based on Structure

1. **Corrosives:** Strong acids and alkalis.
2. **Irritants:** They may be of three types:

(a) Inorganic

- (i) *Non-metallic*: Phosphorus, chlorine, bromine, iodine, etc.
- (ii) *Metallic*: Arsenic, antimony, mercury, copper, lead, etc.

(b) Organic

- (i) *Vegetable*: Castor oil seeds, croton oil, Madar.
- (ii) *Animal*: Snakes, insect bites, cantharides.

(c) Mechanical: Glass, hair, diamonds, etc.**Classification 2: Based on Area of Action and Method****Systemic Poisons****(a) CNS acting****I. Affecting brain:**

- (i) *Somniferous*: Opium, barbiturates, etc.
- (ii) *Inebriant*: Alcohol, ether, chloroform, etc.
- (iii) *Deliriant*: Dhatura, belladonna, Cannabis, etc.

II. Affecting spinal cord: Nux vomica, etc.**(b) Affecting peripheral nerve**: Conium, Curare, etc..**(c) Cardiac poisons**: Aconite, digitalis, oleander, tobacco, hydrocyanic acid, etc.**(d) Asphyxiants**: Carbon dioxide, carbon monoxide, coal gases, etc.**ROUTES OF ADMINISTRATION**

The following are the routes of administration of poisons:

1. Oral, i.e. through mouth.
2. Through inhalation, i.e. by nose/mouth.

3. Through application on skin, mucous membrane like mouth, vagina, anus, nose.
4. Through injection like intramuscular or intravenous.
5. On application on injuries like abrasion, cut wounds or lacerated wounds.

ROUTES OF ELIMINATION

The following are the routes of elimination of poison from the body after metabolism:

1. Urine and faeces are the commonest.
2. Elimination through breast milk.
3. Secretion into saliva or stomach.
4. Elimination through respired air from the lungs.

ACTION OF POISON

The actions of poisons on the body are classified as:

1. Local
2. Remote
3. Systemic
4. General.

When the poison acts on the site of application it is called local effect. Sometimes, poisons may act at a particular place like liver or kidney, then it may be called remote or remote local effect. When a poison affects a particular system like CNS, cardiovascular or GI tract, its effects are called systemic. When multiple organ systems are affected, the effects are called general. It may be possible that poison may affect in more than one way like local and systemic too or affect all systems as in general effect.

Factors Modifying Action of Poisons

The following factors modify the action of poisons in the body:

1. **Quantity:** It is a general rule that more the quantity of poison in the body, more will be its effect. But in some cases, too much of poison can also trigger vomiting which may throw out majority of the poison. A large quantity of poison may sometimes change the mode of action of the poison. Arsenic in large doses may cause death by shock while in small doses it may produce only gastrointestinal symptoms.
2. **Form:** If a poison is administered in gaseous form it acts fastest, while solution acts faster than solid form. Sometimes, the effect of one poison may be countered by another poison which is also taken along with it. If somebody takes silver nitrate and hydrochloric acid together, he will not have any poisonous effect as both poisons would react with each other and produce nonpoisonous silver chloride. Solubility of the poison is also important as some poison may not be water soluble but may dissolve in acid secretion of the stomach. The action of poison may also be altered if an inert substance is mixed with poison as it may reduce absorption from the stomach. If a poison is highly diluted with water, it may not affect at all.
3. **Mode of Administration:** If a poison is introduced into the body via gaseous route it acts the fastest. Parenteral route acts faster than oral route. The mode of administration should be appropriate for the desired effect. Snake venom is very poisonous if injected but harmless if taken by mouth. Application of poison on intact skin acts quite slow as compared to poison applied on mucous membrane.
4. **Condition of the Body:** It has been found that less doses of poison is required for children and old people as compared to young adults. Males tolerate poison better than females. The body may have anaphylactic reaction with any drug or

poison and death may be reported even with small doses. Allergies are genetically inherited and may run in families. If a person is already habituated to a particular poison like alcohol, opium, datura or barbiturates, etc., he may be able to tolerate higher doses as compared to a normal non-addicted person. Drug reaction may occur in body and may potentiate the effect of poison or render it useless. The sedative, hypnotic drugs have positive potentiating effect on level of alcohol once taken. A healthy person can tolerate poison better than a sick person or persons having systemic disorders like hypertension, or diabetes.

FEATURES OF POISONING

Features of Poisoning in Living

It depends upon the nature of poison taken by the person to cause certain characteristics suggesting poisoning but generally following features may be seen:

1. The onset of illness is sudden in a previously healthy person except in chronic poisoning in which it is insidious.
2. The symptoms usually start within 1 hour of consumption of some food, water or drug, if the poison has been given by oral route.
3. The symptoms start increasing and may cause severe bodily disorders even leading to death. Symptoms may start decreasing once a certain time is passed.
4. It may be possible sometimes that persons who have consumed food or water along with a sick person may also show similar symptoms.
5. The final proof of poisoning lies in detection of poison in blood, urine, vomits or faeces. Similar poison can also be detected in left over food or water.

Features of Poisoning in the Dead

The poisoning in a dead person can be established by post-mortem findings, analysis of viscera and circumstantial evidence.

1. **Post-mortem Findings:** The post-mortem should be done very carefully in cases of poisoning. There may be stains of poison on the body or on clothes. Some parts of vomitus may also be seen on clothes or on body. The colour of skin may also point toward the kind of poison. Cherry red appearance in cases of carbon monoxide poisoning may be seen. The skin may appear jaundiced in phosphorus poisoning. If corrosives have been taken, mouth or lips may show changes. Marks of injection may be seen if a poison has been given by injection. But in some poisoning cases, no external findings may be seen.

The internal examination of the body may reveal the following features in the alimentary canal:

- (a) Congestion
- (b) Softening
- (c) Ulceration of mucous membrane
- (d) Perforation.

Congestion: Congestion in the stomach is caused by all irritant poisons. It is more marked at cardiac end. It may appear in patches or may be diffused all over the mucous membrane. Congestion in intestine may be confused with post-mortem staining. Post-mortem staining is always present at the dependent portion of stomach/intestine while congestion may be uniform all over mucous membrane.

Softening: Due to effect of corrosive poisons, the mucous membrane may be softened usually at cardiac end and greater curvature. In softening the mucosa is not detached.

Ulceration: Corrosive or irritant poison can cause erosion of mucous membrane. The margins become thin and friable.

Perforation: Perforation of the wall of stomach may be possible in sulphuric acid poisoning or other irritant poisoning.

2. **Viscera Analysis:** It is very important to preserve viscera to establish poisoning. The whole stomach along with contents, part of small intestine with contents, part of liver, one half of each kidney and spleen (whole) along with samples of blood are preserved in saturated solution of common salt for viscera analysis. The qualitative and quantitative analysis of viscera must be done at the forensic sciences laboratory. Sometimes, the poison may not be detected in the viscera. It may be due to:
 - (a) poison having already been extracted out by vomiting or gastric lavage.
 - (b) poison having already been metabolised in the body and death may be due to other sequelae. In such cases, the clinical findings should be taken into consideration to decide the cause of death.
3. **Circumstantial Evidence:** Sometimes, a bottle of poison may be detected from the site or parts of poison may be seen on clothes. Vomitus may be seen on the scene of crime. The suicide note may be found in some cases.

GENERAL PRINCIPLES OF TREATMENT OF POISONING

The general principles of poisoning are divided into two phases:

1. Emergency management
2. Treatment of poisoning

Emergency Management

Once a medical practitioner comes into contact with a patient of poisoning, he should immediately examine the patient carefully. A history of the

illness should be taken and clinical assessment of the patient should be done immediately. If airways are blocked, they should be made clear either by suction or putting endotracheal tube. The blood pressure should be taken and immediately fluid/blood should be started intravenously to raise blood pressure, if low. Assessment regarding consciousness should be made.

Glasgow Coma Scale

This scale is most commonly used in clinical practice to define the stage of coma. In this, eye response, motor response and verbal response are taken into consideration. Higher the scale by total count, higher is the level of consciousness.

The scale is calculated as follows by totalling all scores in all the three features observed. The scale is described in format as E4 M2 V3. The coma score (E+M+V) varies from 3 to 14 showing deeply comatose to conscious (Table 28.1).

There is another method of grading unconsciousness according to response to painful stimuli and following grades can be seen:

Grade I: Drowsy but responds to verbal command.

Grade II: Unconscious but responds to minimum stimuli.

Grade III: Unconscious but responds only to maximum painful stimuli.

Grade IV: Unconscious and no response.

The rubbing of the patient's sternum with clenched fist is very painful and is commonly used as stimulus in clinical practice.

Treatment of Poisoning

Once the patient is stabilised by taking care of the respiratory system and shock, the treatment of poisoning should begin with following principles:

1. Removal of unabsorbed poison from the body.
2. Use of antidotes.
3. Elimination of absorbed poison from the body.
4. Treatment of general symptoms.

Removal of Unabsorbed Poison from the Body

If the poison has been given through inhalation, the patient should be immediately removed from the site of inhalation. After airways have been secured and made obstruction free, fresh oxygen should be given. If required, artificial respiration through ventilator can be given.

If the poison has been given by injection as in snake bite, a tight ligature may be applied above the wound and the injected site should be cut open and poison may be sucked through a suction pump. It may be neutralised also by local application of antidote if available.

If the poison has come into contact with the skin, mucous membrane, or thrown into eyes like corrosives or irritants, it should be washed with water or a suitable antidote. Thorough lavage should be done.

If the poison has been taken through oral route, it should be removed by gastric lavage.

Table 28.1 Glasgow comma scale

<i>Features observed</i>	<i>Score</i>
1. Eye opening	
(a) Spontaneous	E4
(b) On speech	E3
(c) On pain	E2
(d) No response	E1
2. Best motor response	
(a) Obeys all commands	M5
(b) Localises	M4
(c) Flex	M3
(d) Extends	M2
(e) Nil	M1
3. Best verbal response	
(a) Oriented	V5
(b) Confused conversation	V4
(c) Inappropriate words	V3
(d) Incomprehensible sounds	V2
(e) Nil	V1

Gastric Lavage

The gastric lavage should be done in conscious patients. If the patient is unconscious and gastric lavage has to be done, a cuffed endotracheal tube should be introduced so that nothing from oesophagus/stomach enters the airway. The gastric lavage is done by gastric lavage tube which is about 1.5 metre, made of non-collapsible rubber tube, about 1 cm in diameter and has a funnel attached to it. Other tubes like Levine tube or Ryle's tube can also be used. A mouth gag is there in the tube so that patient cannot bite the tube. The tube is lubricated with glycerine or olive oil, and is introduced into the mouth. The patient is asked to swallow it. Then, it should be introduced slowly so as to reach the stomach. Make sure that the tube is in stomach and not in trachea by pushing air through tube and listening the voice over abdomen by stethoscope. Patient should be on left side or prone with head hanging over the edge of the bed. Length of the tube to be inserted in adult is 50 cm, while in child it is 25 cm. About 300 ml of plain water or warm water should be poured into funnel keeping it high over abdomen. By gravity action, water will enter the stomach. Once it is reached, funnel is lowered and then kept below the level of abdomen. By siphon action, wash from the stomach would come out through funnel.

The first washing should be preserved for chemical analysis. The stomach wash should be done till a clear solution of water is obtained. The gastric lavage is very useful if it is done within 2 to 4 hours of ingestion in most cases but in cases of certain drugs like salicylates, phenothiazines, antidepressants, etc., it can be of help in even up to 12–18 hours of poisoning.

1. Contraindications

- (a) Corrosives except carbolic acid
- (b) Convulsions
- (c) Petroleum products
- (d) Oesophageal varices (already present)
- (e) Hypothermia
- (f) Foreign body ingestion like pin, nail, etc.

2. Complications of Gastric Lavage

- (a) Aspiration pneumonia
- (b) Vomiting
- (c) Damage to gastric mucosa/oesophageal mucosa
- (d) Perforation, rarely.

After the gastric lavage is complete, stomach may be left empty or a specific antidote may be left if poison is known. If poison is not known, activated charcoal suspension may be kept.

Emesis

If the patient is conscious and co-operative, emesis can be induced. The vomited matter should be kept for chemical analysis. The vomiting can be induced as follows:

1. Tickling of fauces by finger or leaf.
2. Copious amount of warm water taken by mouth.
3. Gargling with soapsuds (non-detergent)
4. Solution of common salt or mixed with mustard oil may be given.
5. Syrup of ipecac can be given orally.
6. Ammonium carbonate dissolved in water.
7. Apomorphine given subcutaneous in cases where respiratory depression is not there, is quite effective. But it has got a lot of side effects. It should be best avoided.

Emesis should not be attempted in corrosive poisoning or petroleum products poisoning. However, it must be remembered that emesis is not as effective as gastric lavage.

Use of Antidotes

Antidotes are defined as agents which counteract the effect of poisons. They are of various types such as mechanical, chemical, physiological or specific receptor antagonist.

1. **Mechanical Antidotes:** These antidotes act by rendering poison useless by mechanical action. Common example is activated charcoal which acts by absorbing and

retaining poisons within its fine pores. Fats, oil and egg albumin are also mechanical antidotes which act by forming a coating on mucous membrane of stomach and hence retard absorption.

2. **Chemical Antidotes:** They act by forming harmless compound or insoluble solution when come in contact with poison. Weak acids are used for strong alkalies. A very important chemical antidote is potassium permanganate which is a good oxidising agent. It is quite useful in opium poisoning, phosphorus, hydrocyanic acid, morphine, atropine and other alkaloids. It is used as stomach wash. First wash should be with plain water so that the first wash can be preserved for chemical poisoning testing and then potassium permanganate is added.
3. **Physiological Antidotes:** They act on tissues of the body and produce symptoms exactly opposite to those caused by poison acting on them or the enzymes. Common example is neostigmine used in dhatara poisoning to counter the effect of atropine.
4. **Specific Receptor Antagonist:** It blocks the action of the drug or poison at its target receptors. Atropine and physostigmine are the two antagonist which act just opposite to each other. Other examples include BAL, EDTA, penicillamine and Desferal which are chelating agents. They act on the tissue cell and dislodge the metallic ions. For this action, they are used in metallic poisoning.

Elimination of Poisons Absorbed into the System

Intravenous fluids should be given in sufficient quantity so that the kidneys are able to excrete poisons. It should be noted that the person should not be overloaded with fluids. Diuresis can be

induced by using mannitol. Forced acid diuresis is helpful in amphetamine poisoning while alkaline diuresis is helpful in aspirin and barbiturate poisoning. Peritoneal/hemodialysis can be done as it is useful in poisonings like barbiturates, bromides, salicylates, methyl alcohol and digitalis. Blood transfusion can be done and is very helpful in children. Purgatives can also be used, if needed.

Management of General Symptoms

The shock should be managed by introducing intravenous fluids. Pain should be taken care of by analgesic or injecting morphine if not contraindicated. Air passages should be kept open by endotracheal intubations, if necessary.

The nutritional aspect of poisoning should be taken care of. Adequate amount of dextrose solution should be given if the patient is not able to take himself. Feeding by gastric tube can be considered in cases where patient is unable to feed by himself.

POISON INFORMATION CENTERS

In 1994, National Poison Information Centre was started at the All India Institute of Medical Sciences, New Delhi. WHO has provided its software on poisons (INTOX) from where complete information about poison regarding its composition, diagnosis, clinical features and treatment is made available to public. Second centre was opened at the National Institute of Occupational Health, Ahmedabad. New centres have also come up at the Government General Hospital, Chennai, Industrial Toxicology Research Centre, Lucknow and Amrita Institute of Medical Sciences, Cochin. The Government of India plans to open more centres all over India. All these centres can be assessed by common public or medical community to know about nature and treatment of any poison.

Corrosive Poisoning

Corrosives are mainly acids and alkalies. Acids are further divided into:

- (a) Inorganic acids or mineral acids
- (b) Organic acids
- (c) Halogens.

INORGANIC ACID POISONING

The common inorganic acids are sulphuric acid, hydrochloric acid and nitric acid.

Mechanism of Action

These strong acids have tendency to corrode tissues. They cause coagulation necrosis by coming into contact with tissue protein by precipitation. As a result of which there is extensive local damage. The acids do not have remote effect. The walls of oesophagus are more resistant to acid action but stomach mucosa is not. Acids when taken in diluted form, act as irritants. When acids are diluted too much, they act as stimulant as in case of hydrochloric acid.

Treatment

Gastric lavage tube should not be introduced as it may cause perforation in the stomach wall. The mineral acids present in the stomach should be neutralised by water or milk in which calcium or

magnesium oxide along with aluminium hydroxide may be added. Use of weak alkalies for neutralisation should not be used. The patient should not be given anything orally for 2–3 days after introduction of water or milk. The role of antibiotics and steroids is controversial. Total parenteral nutrition has also been advocated for stricture control but still it is controversial. Endoscopy is the standard practice in evaluation of such a patient. It is best performed within 24–48 hours of ingestion. Laryngoscopy must be done before endoscopy as sometimes supraglottic-epiglottic burn may be there causing oedema and thus causing airways obstruction. In such cases, endotracheal intubation should be done. If needed, laparotomy may be performed. If gastric necrosis is seen, an oesophagogastrectomy may be performed. Another controversial method to prevent stricture formation is to insert a siliconised nasogastric tube in patients where endoscopy shows second degree burn.

Gastric perforation and peritonitis are indications for immediate laparotomy. Late treatment includes oesophagoscopy followed by dilatation of stricture and surgery for oesophageal revision or replacement.

Local Applications

Local effect of mineral acids on skin should be treated as per treatment of burns. They should be

washed with copious amount of flowing water. Later, surgical debridement may be undertaken. Locally, antiseptics and antibiotics should be applied to infections. Contractures may develop if the area burnt is extensive, and may require surgical treatment. Acids falling into eyes should also be treated similarly and ophthalmic damage should be taken care of by putting antibiotics. For pain relief, morphine may be given.

Sulphuric Acid (H_2SO_4)

It is also called 'battery acid' or 'oil of vitriol'. It is the most powerful acid. It is colourless, heavy and hygroscopic. It mixes with water but evolves heat when mixed. Its chemical formula is H_2SO_4 . It chars anything which comes into contact with it. Commercially a stronger version pyrosulphuric acid is also used. Its chemical formula is $H_2S_2O_7$ and is used in the manufacture of indigo.

Special Symptoms

The tissues get dehydrated when this acid comes into contact as this acid has great affinity for water. A lot of heat is produced causing acid burns, blackening and charring. Burning pain in mouth, throat and stomach may be seen. Tongue is swollen and is covered with white coating looking like parchment, which later becomes dark and then brown. It may become corroded and may look like a shapeless mass if acid is concentrated. The teeth become chalky white in colour as their polish is gone. The lips are swollen and black streaks may be seen on angles of mouth due to action of acid.

Fatal Dose

It is mostly dependent on concentration. The more concentrated acid is, less is the fatal dose. About 5 ml of concentrated acid is sufficient for adults.

Fatal Period

The average fatal period is 18–24 hours.

Post-mortem Appearance

The usual appearances of corrosive poisoning are present. The mouth, lips and surrounding skin show brown or black corroded spots. There may be blackening of stomach mucosa along with necrosis or perforation may be seen. The small intestine may also show corrosion or blackening. Signs of peritonitis, strictures may be seen when death is delayed. Fatty changes may be seen in liver and kidneys.

Medico-legal Significance

As sulphuric acid is commercially used extensively, it is easily available. Accidental drinking is usually not possible but can occur in children. Since it is very strong, it cannot be used as homicidal poison as it affects food itself.

Vitriolage (Acid Throwing)

It is commonly seen when a person wants to disfigure the face of another person. Women are common victims. A person who is jilted in love may throw acid on the woman to teach her a lesson. Usually the acid is collected in a bulb and is thrown on the person while moving on a cycle or a motorcycle. Eyes may also be affected. Corneal destruction or even blindness can result. The acid thrown on face causes severe pain, corrosion of tissues leading to permanent scar. The treatment includes immediate washing with water till pain persists or acid is washed off. A thick paste of magnesium oxide or carbonate may be applied later on. Antibiotics should be given to prevent infection. The wound may be dressed later on. Sometimes, skin grafting is needed to replace the damaged skin. If eyes are involved, they should be immediately washed with water and then the damage should be taken care of by putting antibiotics.

Accidental contact with sulphuric acid is possible in people working in factories and manufacturing establishments where acid is used.

Nitric Acid (HNO₃, Aqua Fortis)

Chemical Properties

It is a clear, colourless liquid, gives fumes when exposed to air. It is a very powerful oxidising agent and can dissolve all metals except gold and platinum. Commercial preparation may be of yellow colour due to the presence of lower oxides of nitrogen.

Special Poisoning Symptoms

Owing to property of nitric acid to convert protein into xanthoproteic acid, the lips, tongue and mucous membrane of the mouth are first softened and white in colour and later turn intense yellow. The teeth also become yellow. The skin and clothes also become yellow. These yellow stains can be confirmed by addition of ammonia water when they turn orange. A lot of gas is produced when nitric acid acts on organic tissues in stomach. The abdomen becomes quite distended and tender. Oliguria or anuria may be seen. Fumes of nitric acid can cause irritation in eyes leading to damage. Fumes may also cause dyspnoea and constriction in throat when inhaled.

Fatal Dose

About 8–10 ml.

Fatal Period

About 12–24 hours.

Post-mortem Appearance

The skin and mucous membrane are corroded and appear yellow. The stomach wall is soft and ulcerated. Perforation is less common than sulphuric acid. Other usual features seen in sulphuric acid poisoning are present.

Medico-legal Significance

In arts and manufacturing, nitric acid is extensively used. It is also used for cleaning ornaments. Accidental poisoning is common among workers. Cases of poisoning by nitric acid are quite less.

Hydrochloric Acid (HCl)

It is also called muriatic acid or 'spirit of salts'. The chemical formula is HCl.

Properties

In pure form it is a colourless gaseous liquid and has an irritating smell. It dissolves in water easily to form acid of commerce or muriatic acid. It has yellow colour and fumes in air.

Special Symptoms

It is quite less damaging as compared to sulphuric and nitric acid. It does not stain mucous membrane. In large dilution, this acid is harmless and helps in digestion. But in strong doses it corrodes mucous membrane. Perforation is quite rare. Fumes when inhaled, cause great irritation to respiratory passages.

Fatal Dose

15–20 ml of concentrated acid.

Fatal Period

18–30 hours.

Post-mortem Appearance

The mucous membrane affected by acid is ash grey or black with erosions. The stomach wall is red due to gastritis caused by acid. Perforation is rare. Ulceration is very common.

Medico-legal Significance

Hydrochloric acid is used in industry for chlorine production. It is also used for dissolving metals and in pharmaceutical industry. Accidental and suicidal poisoning have been reported in people working in the industry. Homicidal poisoning is very rare.

ORGANIC ACID POSONING

Carbolic Acid

It is also called phenyl, phenyl alcohol or phenic acid. The chemical formula is C₆H₅OH. It is commonly prepared from acetylene by synthesis.

Carbolic acid is a common household poison. It is largely used as an antiseptic, a disinfectant and a preservative. It is used for cleaning floor and toilets. Pure carbolic acid occurs as colourless, prismatic crystals. It has got a characteristic odour. The crude carbolic acid of commerce is a dark brown liquid containing many impurities like cresol. Dettol, a commercial preparation commonly used as antiseptic is a chlorinated phenol with turpeneol. It is non-toxic even when consumed in high doses.

Poisoning by carbolic acid is called **Carbolism**. The acid in concentrated form acts locally as corrosive. It acts as a narcotic poison remotely. It causes coagulation of proteins but does not chemically combine with them. When applied to skin, it causes burning sensation, numbness and anaesthesia as it affects sensory neuronal endings. It causes white opaque eschar on skin which heals in 3–4 days leaving behind brown stain.

The carbolic acid causes irritation and necrosis of mucous membrane leading to sloughing when applied in concentrated form.

Symptoms

When consumed in concentrated form, there is intense burning and thirst in mouth and throat. The mucous membrane of lips and mouth becomes white. It is rapidly absorbed in blood and it causes giddiness, insensibility, followed by deep coma. The face becomes pale or cyanosed, skin becomes cold and clammy, the blood pressure starts falling leading to shock. Initially there is respiratory alkalosis but soon it is followed by respiratory acidosis. There is an offensive smell of carbolic acid in breath. Convulsions may follow. Urine production is suppressed. When urine is passed, it is normal in colour, or of a greenish hue. The urine becomes dark or olive green when exposed to air. This colour change is due to further reduction of hydroquinone and pyrocatechol which are oxidation products of carbolic acid present in urine. This is called carboluria. Death may result due to respiratory failure.

Fatal Dose

2 gm is average fatal dose.

Fatal Period

3–4 hours.

Treatment

Ordinary emetics do not work. Gastric lavage is essential. A soft gastric lavage tube can be passed easily as there is no risk of perforation in carbolic acid poisoning. The mucosa of the stomach becomes hard and leathery due to carbolic acid. The stomach should be washed with water. Castor oil or olive oil may be left behind after gastric lavage is complete. Demulcents such as egg white, or milk can be given. Sodium sulphate may be given after some time. Sodium bicarbonate should be given intravenously to counter circulatory depression. Hemodialysis should be done. Supportive measures should be given. Local burns on skin due to carbolic acid should be treated with plain water first and later castor oil or olive oil may be applied.

Post-mortem Appearance

Dark brown excoriations may be seen along the angles of mouth. The mucous membrane of lips, mouth and throat is congested, ash grey or white in colour. The mucous membrane of oesophagus is also seen as white or grey. The mucous membrane of stomach is hard, leathery and white in colour. Smell of carbolic acid may be present in the gastric contents. The lungs are congested and oedematous. The kidneys may show haemorrhagic nephritis. The brain may be congested.

Medico-legal Significance

Accidental and suicidal poisoning is quite common as it is a household poison extensively used as antiseptic, disinfectant and preservative. Due to powerful smell, it is not used as a homicidal poison. Accidental poisoning is common in children.

Acetyl Salicylic Acid (Aspirin)

The chemical formula is $C_9H_8O_4$. This occurs as white, odourless, crystalline powder having acidic taste. It does not dissolve in water easily. The acetyl salicylic acid is very extensively used as an analgesic, and is a component of various medicines used in the management of fever, skeletal pain, control of inflammation, arthritis, etc.

Symptoms

Headache, dizziness, thirst, epigastric distress, nausea and vomiting are common features. Hematemesis may also occur. Later, red and swollen face, weak and rapid pulse, hyperpnoea, profuse perspiration and dehydration may be seen. Mental changes commonly known as salicylate gags may be there followed by drowsiness and coma. Hypersensitivity to salicylates has been also reported. There may be anaphylactic reaction, urticaria and angio-neurotic oedema. When plasma salicylate levels are between 35 and 50 mg per 100 ml of blood or above, a primary respiratory alkalosis is reported as stimulating effect of salicylates on respiratory system leads to hyperpnoea and loss of CO_2 results. Later, metabolic acidosis supervenes due to increased excretion of bicarbonate, potassium and sodium. Renal function may be disturbed. Toxic encephalopathy may occur. Death may occur due to cardiac or respiratory failure.

Fatal Dose

5–10 gm of aspirin is the minimum fatal dose. 20–30 gm is an average fatal dose. Death may occur due to hypersensitivity reaction, even with one tablet.

Fatal Period

It may range from a few minutes to several hours.

Treatment

Gastric lavage should immediately be done with normal water, and activated charcoal should be

given. Kidney function may be taken care of by giving a lot of fluid either by oral, or intravenous route. Metabolic acidosis should be corrected by giving sodium bicarbonate. Hemodialysis or peritoneal dialysis should be done at the earliest. Vital functions should be maintained by giving oxygen and intravenous solutions. Vitamin K should be administered if clotting time is prolonged. Forced alkaline diuresis is the key treatment to achieve a urinary pH of more than 7.

Post-mortem Appearance

The gastric mucosa may show haemorrhages and ulcerative lesions. In brain haemorrhage may be seen. Rest of the findings are non-specific.

Medico-legal Significance

Accidental poisoning is common when it is taken in large doses. Aspirin is a very commonly used medicine. Children may consume it accidentally. Suicidal poisoning is very less but reported. Homicidal poisoning is very rare as very large doses are required to kill a person.

Acetoaminophen (Paracetamol)

As paracetamol is much preferred over aspirin in management of fevers, it is widely used. Accidental poisoning is quite common.

Symptoms

Toxicity due to paracetamol can be divided into four stages:

Stage I: It occurs between 12 and 24 hours after ingestion. Nausea, vomiting, diarrhoea and pallor may be seen.

Stage II: It occurs 24–48 hour after ingestion. Clinically the patient appears better, but his liver functions are deranged. SGOT, SGPT, bilirubin and prothrombin time increase during this stage.

Stage III: It occurs 48–96 hours after ingestion. Peak hepatotoxicity can be seen. Acute renal failure may occur. Myocardial damage may be seen.

Stage IV: It occurs 7–8 days after ingestion. Recovery may be seen.

Mechanism of Toxicity

Paracetamol is metabolised by sulphation and glucuronidation. But a small fraction of paracetamol is converted into toxic metabolite by cytochrome P450 oxidase enzyme present in hepatic cells. In overdoses, this metabolite causes hepatotoxicity.

Management

Gastric lavage should be performed immediately. N-acetylcysteine should be given as early as possible via intravenous route or oral route. Monitor the liver and renal functions. Forced diuresis and hemodialysis are of not much use. The vitals should be maintained. The conservative treatment should be followed.

Medico-legal Significance

Accidental poisoning with paracetamol is common among children and adults. Suicidal poisoning may be seen but homicidal poisoning is rare.

HALOGEN POISONING

Chlorine, bromine and fluorine are the most important halogens. They combine with hydrogen to form acids.

Chlorine

It is a greenish yellow gas with a pungent smell. The chlorine gas is used for water purification, sewage treatment, in drug and cosmetic industry and as a bleaching agent for cotton and paper.

Mechanism of Action

Due to highly oxidative nature of chlorine, it causes rapid and extensive destruction of tissues.

Clinical Features

Chlorine is a highly irritant gas. When inhaled, it causes coughing, chest pain, dyspnoea,

rhinorrhoea and lacrimation. It causes pneumonitis and severe pulmonary oedema. Severe metabolic acidosis is seen along with vomiting, vertigo and ventricular ectopic beats. Corrosion of teeth may be seen in chronic poisoning among workers.

Fatal Dose

Concentration above 50–100 ppm can cause death.

Treatment

Mild poisoning does not require much treatment. The person should be given oxygen for sometime. In severe poisoning, sodium bicarbonate can be given through nebuliser as it would neutralise the acid formation in airways. Oxygen therapy should be continued for long. Eyes should be treated with water.

Post-mortem Features

The characteristic features are massive pulmonary oedema, loss of respiratory epithelium and characteristic pungent smell.

Medico-legal Significance

Mild poisoning occurs sometimes in swimming pool where chlorine is used as disinfectant. Accidental industrial poisoning can occur in workers involved in industries where chlorine is used.

Iodine

The iodine emits a characteristic smell and constantly gives off violet coloured vapours. Iodine is a constituent of antiseptic preparation like tincture of iodine, povidone iodine and Lugol's iodine. Iodine is also a part of common expectorants, anti-asthmatics, antiamebics, anti-fungals, anti-thyroid drugs and contrasts used in radiological investigations. Iodine when locally applied, is a great irritant. When ingested, it causes severe metabolic acidosis.

Clinical Features

When iodine is ingested, it causes intense irritation in the gastrointestinal tract. Nausea, vomiting and diarrhoea are seen. Vomiting and stool may appear yellow. When locally applied, skin and mucous membranes appear yellow. Iodide salts are less toxic and usually require no treatment. But chronic poisoning called 'Iodism' can occur due to prolonged use of iodine salts. The common clinical features of iodism are metallic taste, anorexia, parotid swellings sometimes referred to as iodide mumps, lymphadenopathy, rhinorrhoea, stomatitis and conjunctivitis. The other clinical feature is ioderma consisting of erythema, urticaria and acne.

Fatal Dose

2–5 gm of free iodine.

Treatment

Same as chlorine poisoning mentioned above.

Post-mortem Features

The characteristic features include yellowish stains on skin and mucosa, and pungent smell on opening the body.

Medico-legal Significance

Accidental poisoning occurs when therapeutic mixtures containing iodine are taken in large doses. Occupational toxicity can occur in workers involved in industry. Radiological contrasts containing iodine are notorious to cause severe allergic reaction and sometimes deaths are seen.

Fluorine

It is a colourless gas which becomes fuming liquid when it is dissolved in water. Fluorine is used in etching on glass. It is an intense irritant to skin and mucous membrane when inhaled. The symptoms are similar to those of chlorine and iodine.

Sodium fluoride and sodium silicofluoride are white crystalline powders. They are used as wood

preservatives and for etching on the glass. They are also used as insecticides and marketed as cockroach powder. When fluorides are taken in, they precipitate calcium and inhibit many enzymes causing damage to kidneys and brain. Severe ulceration or charring may be seen on lips, tongue and mouth. Nausea, vomiting, diarrhoea and shock are seen.

Fatal Dose

4 gm of sodium fluoride is sufficient to kill a person.

Fatal Period

1–2 hours.

Treatment

On the same lines as mentioned for chlorine poisoning.

Medico-legal Significance

Accidental and suicidal poisoning are reported. Chronic poisoning is seen among workers exposed to fluorine.

ALKALIES**Mechanism of Action**

The action of alkalies is like that of acids. They produce corrosions when administered in concentrated form. They act as irritants when administered in diluted form. Strong alkalies can produce burns in oesophagus and may cause oesophageal stricture. With fat, alkalies form soap and with protein causing protonation. The common alkalies are as follows:

1. **Ammonia:** The chemical formula is NH_3 . The gas of ammonia when dissolved in water forms a strong ammonia solution commonly also called 'spirits of Hartshorn'. It is a very strong alkali with a pungent odour. It is commonly used in refrigeration and fertiliser industry.

2. **Potassium Hydroxide:** The chemical formula is KOH. It is hard, deliquescent and is available as pencils or cakes. It is soapy to touch, acrid in taste and is very soluble in water. It is a highly strong alkali.

3. **Sodium Hydroxide:** The chemical formula is NaOH. It is a white, solid mass and resembles potassium hydroxide. It too, is highly soluble in water and is a very strong alkali. Mixture of sodium and potassium hydroxides is commonly referred to as 'lye'. It is used for drain or oven cleaner.

4. **Ammonium Carbonate:** The chemical formula is $(\text{NH}_4)_2\text{CO}_3$. It occurs as translucent, hard and crystalline mass. It is quite soluble in water and emits smell of ammonia. It is a very strong alkali.

5. **Potassium Carbonate:** It is also known as 'pearl ash', 'salt of Tartar' or 'Javakhar'. It is a white, crystalline powder. It is a very strong alkali, used mainly for cleaning purpose. The chemical formula is K_2CO_3 .

6. **Sodium Carbonate:** It is also known as 'washing soda', 'Sajjikhara', or simply as soda. The chemical formula is Na_2CO_3 . It is transparent, monosymmetric crystal and becomes white when exposed to air. It is quite soluble in water. It is a strong alkali, commonly used for washing and cleaning purposes.

Symptoms

The alkalis produce usual symptoms as acids except the following:

1. The taste of alkalis is acrid and soapy.
2. The vomited matter is very alkaline and does not effervesce as in acids when comes in contact with earth.

3. Purging is quite common in alkalis while it is rare in acids. Severe pain with bloody diarrhoea may be seen.

The ammoniacal vapours are very irritating to respiratory systems. They produce congestion and watering of eyes too. Pulmonary oedema may be seen.

Fatal Dose

30 ml of ammonia is fatal. 5 gm of caustic soda is fatal.

Fatal Period

Within 24 hours, death can occur.

Treatment

Gastric lavage is contraindicated in strong alkalis. In milder cases only it can be done. Alkalis may be neutralised by vegetable acids like vinegar, lemon or orange juice. It should be followed by olive oil or white of egg, milk, etc.

Rest of treatment on conservative lines, is same as that of acids. The oesophageal stricture should be handled carefully.

Post-mortem Appearance

Corrosions are seen in alimentary canal but not as extensive as seen with mineral acids. Perforation is rare but may be seen in ammonia.

Medico-legal Significance

Poisoning by alkalis is much less as compared to acids. Most of the poisoning is accidental or suicidal. Homicidal poisoning is very rare. Caustic soda may be locally applied to neck of ox or buffalo to make it unfit for agricultural purpose, so that it would not be able to bear yoke of a plough due to the local corrosive effect of caustic soda.

CHAPTER 30

Irritant Poisons—Vegetable Poisons

The following vegetable poisons commonly cause poisoning.

***RICINUS COMMUNIS* (CASTOR OIL PLANT, ARANDI)**

It belongs to the family Euphorbiaceae. There are two types of seeds – a large red seed with brown blotches yielding about 40 per cent of oil which is used for illumination, and a small grey seed having bright, polished, brown spots, yielding about 37 per cent of oil, commonly used for medicinal purpose. The seeds of castor oil plant



Fig. 30.1 Castor plant with seeds.

contain an active principle called *ricin*. Ricin is a water soluble glycoprotein. It is a toxalbumin (Fig. 30.1 and 30.2).

Toxalbumin or phytotoxin is a toxic protein which causes agglutination of red blood cells leading to haemolysis and cell destruction. Its action resembles bacterial toxin. Toxalbumin acts as an antigen when injected into body and antibodies are produced. When the oil of the castor seed is extracted, the residue is very poisonous as it contains ricin.

Symptoms

The castor oil seed is not poisonous if taken as such, as pericarp of seeds are not dissolved by intestinal secretions and the seeds are passed out in toto in stool. It is poisonous when crushed seed is given. A few hours after ingestion of the seeds, the gastrointestinal symptoms starts. There is burning pain in throat, nausea, vomiting, thirst, and colicky pain in the abdomen. Diarrhoea with blood may be seen. Slowly, signs of dehydration appear as feeble pulse, low blood pressure, cold clammy skin and finally death due to shock. Oliguria may be seen.

Fatal Dose

Ten crushed seeds are fatal.

Fatal Period

It can be 1–2 days.

Treatment

Gastric lavage must be done immediately. Hypovolaemic shock should be treated with rapid infusion of fluids. Symptomatic treatment should be followed.

Post-mortem Appearance

Signs of irritation like congestion, softening and inflammation of mucosa of alimentary canal is seen. Ulceration may be seen. Fragments of seeds can be detected and should be preserved for analysis.

Medico-legal Significance

Oil of castor seed is commonly used as purgative in clinical practice. It is widely used by homeopaths and those practising ayurveda and unani systems of medicine. Poisoning by seed can be accidental especially in children. Suicidal poisoning is rare. Homicidal poisoning is reported. The powder of seeds can cause conjunctivitis when applied to eyes. Ricin is excreted into intestinal epithelium.

CROTON TIGLIUM (CROTON, JAMALGOTA)

It belongs to the family Euphorbiaceae and is widely grown. The seeds are very poisonous. They

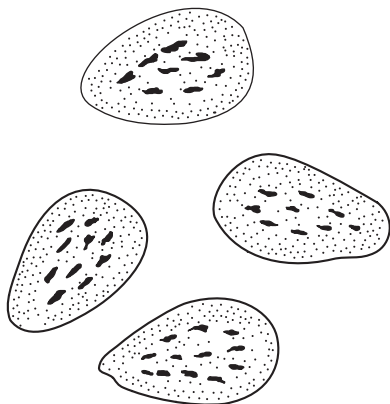


Fig. 30.2 Croton seeds.

contain croton, a toxalbumin and crotonoside a glycoside (Fig. 30.2).

The croton seed oil contains a very powerful vesicating resin composed of crotonoleic acid, methyl crotonic acid, crotonol and several fatty acids. The croton oil has disagreeable smell and acidic taste. When it comes in contact with skin, it produces redness, itching and blisters. When taken internally by mouth, it produces irritation of mucosa.

Symptoms

Croton oil is a strong irritant of alimentary canal. Immediately, there is intense pain in throat, abdomen, vomiting and diarrhoea which may later become bloody. The purging is very severe. The person may die because of acute dehydration leading to hypovolaemic shock.

Fatal Dose

Even one seed is sufficient to cause death.

Fatal Period

Death may occur in 12–24 hours.

Treatment

Perform gastric lavage and correct the dehydration with intravenous fluids.

Post-mortem Appearance

The mucous membranes of stomach and intestines would be seen as inflamed and ulcerated. The signs of hypovolaemic shock may be seen. Croton seed or residue may be seen.

Detection of Seeds

The croton seeds are broad, oval, measuring 1.27 × 0.84 cm, and odourless. There is dark brown shell, outside of which on scraping becomes black. The kernel is very oily and white in colour. The seeds

resemble castor seeds except that they are not bright, polished and mottled.

Medico-legal Significance

Croton oil is widely used as purgative by quacks, ayurved and unani physicians. Croton oil is also sometimes used by quacks as abortifacient. It can be administered orally for homicidal purposes. Accidental poisoning is reported. Suicidal poisoning is rare. The person may develop diarrhoea even if croton oil is used on skin, as crotonoleic acid is excreted into the intestine.

ABRUS PRECATORIOUS (RATTI)

It belongs to family the Leguminosae and is widely grown all over India. The plant is a climbing one. The seeds are egg-shaped, scarlet in colour with a black spot at one end. The seeds weigh around 105 mg, dimensions are 0.83×0.62 cm. They were previously used by Indian goldsmiths for measuring gold and silver. The white variety of the seeds is also there. The seeds of *ratti* contain abrin, a thermolabile toxalbumin. Its actions are similar to ricin. The seeds of *ratti* also contain abruassic acid, urease, hemagglutinin, fat splitting enzyme and some poisonous proteins (Fig. 30.3).

Since abrin is thermolabile and it is inactivated by hot water, the *ratti* seeds are harmless if they are boiled properly. The root and stem of *ratti* plant contains active principle of glycyrrhizin.

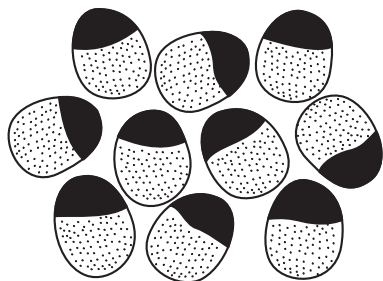


Fig. 30.3 *Ratti* seeds.

Symptoms

If powdered seeds are ingested orally, they produce gastrointestinal symptoms like vomiting and diarrhoea. If extract of seeds is injected in the skin it produces inflammation and oedema leading to necrosis around the site of injection. Death may occur due to peripheral vascular collapse. Convulsions may be there.

Ratti is widely used as animal poison. The seeds may be crushed and mixed with dhatura, opium and onion to form a paste, which is then made in the form of needles which are then hardened in the sun. These needles are then placed in a wooden handle (Fig. 30.4). These are inserted into the animals, especially around genitalia, anus or vagina. In a few hours, inflammation and oedema appear on the site. Later necrosis may occur. The animal dies within 3–4 days due to peripheral shock. Convulsions may be there. The symptoms closely resemble those of a snake bite especially viper bite. It may appear that animal has been bitten by snake.

Fatal Dose

90–120 mg.

Fatal Period

3–4 days.

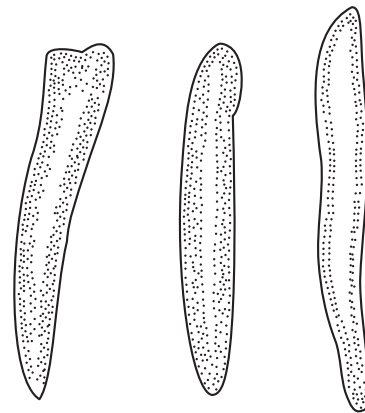


Fig. 30.4 *Suis* made from *ratti* seeds.

Treatment

Local administration of anti-abrin is quite useful. Gastric lavage is indicated if the seeds are taken orally. The treatment is mainly supportive.

Post-mortem Appearance

Fragment of needles (commonly called *suis*) can be found in the locally inflamed area of the animal. Generalised symptoms like oedema of the lungs, and congestion of body organs may be seen. The mucosa of the stomach may be congested if seeds are taken orally.

Medico-legal Significance

The seeds of *ratti* are commonly used for destroying cattle due to jealousy. The needles (*suis*) which are used for killing animals may also be used for homicidal purposes. In this, the person is slapped with the needle kept in between two fingers and the poison is administered by pushing the needle in the face.

Accidental poisonings are reported. Suicidal cases are quite rare. Seed extract can be used to produce conjunctivitis.

CLAVICEPS PURPUREA (ERGOT)

Ergot is a parasitic fungus which grows on several plants such as *rye*, oats, wheat, barley and *bajra*. It is also cultivated in hilly areas. Ergot is lighter than air and its spores travel widely through wind. The ergot has a peculiar odour and a disagreeable taste. Ergotoxin, ergotamine and ergometrine are the principal alkaloids present in ergot.

Ergometrine produces effects more rapidly but gangrene is not commonly seen. Prolonged use of ergometrine does not produce nausea, headache and depression.

Ergonovine maleate is a medicinal preparation prepared from ergometrine and is a uterine stimulant.

Ergot is widely used in the treatment of migraine, although prolonged use may produce gangrene of lower limbs.

Acute Poisoning

Initially, there is dryness and irritation of throat, nausea, vomiting, burning pain in stomach, diarrhoea, numbness, paraesthesia, disturbance of vision followed by weak rapid pulse, angina, muscular weakness, coma and death. Epistaxis, hematemis, haematuria may also be seen along with jaundice.

Chronic Poisoning (Ergotism)

The chronic poisoning is seen in individuals who keep on taking ergot preparations for medicinal purposes for a long time or in those who keep on eating grains infested with ergot fungus.

Symptoms

Initial symptoms are gastrointestinal. Soon, they are followed by either *convulsive* or *gangrenous* form. In convulsive form, there are neurological symptoms like itching, numbness, tactile hallucinations, paraesthesia, and pain while walking. Soon, convulsions start. Fixed dilated pupils, loss of hearing, depression may be followed by death due to asphyxia as a result of respiratory muscle failure. In the gangrenous form, it starts with vague pain in limbs, tingling sensation and later numbness of fingers and toes due to vasospasm. The limbs become swollen and all sensations are gone. There is damage to the intima of small blood vessels leading to gangrene, which is usually of dry type. Usually, the fingers and toes are affected but sometimes elbow or knee are also affected.

Fatal Dose and Fatal Period

Usually, chronic poisoning causes death over a long period of consumption.

Treatment

The source of ergot alkaloids should be stopped immediately. The person should be managed on supportive treatment. Dialysis is quite helpful in chronic cases.

In acute poisoning, gastric lavage must be done immediately and supportive measures should be started.

Medico-legal Significance

Ergot is largely used as an abortifacient. Ergot is highly effective on contracting uterus.

CAPSICUM ANNUUM (RED CHILLIES)

Capsicum fruits are grown all over India. They are powdered and are used as spices in preparing vegetables and chutneys and pickles. It belongs to the family Solanaceae. The active ingredients are capsaicin and capsin. The pungent nature is due to an alkaloid (Fig. 30.5).

Symptoms

In large doses capsicum acts as an irritant poison. It produces burning sensation in mouth and stomach. It causes severe acute acidity. The oesophagus, stomach and small intestine are inflamed and necrosis may be seen. Large intake of chillies may cause peptic ulcer. When chili

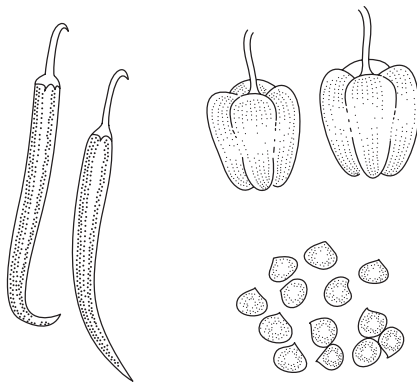


Fig. 30.5 Capsicum with seeds.

powder is thrown into eyes, it causes redness, itching and inflammation of conjunctiva.

Medico-legal Significance

Chilies are also used in human torture. Chili powder is put in vagina, rectum, urethra, eyes and rubbed over breasts. The chili seeds resemble datura seeds. **Hyderabad Goli** is the term used by people who are doing torture when they put chillies in the rectum.

SEMERCARPUS ANACARDIUM (MARKING NUT TREE)

The fruit of this tree is called 'marking nut'. It is commonly used by washermen to put marks on clothes. The fruit is around 2–4 gm in weight, and has a hard, black rind within which lies thick pericarp. The juice of the pericarp contains brownish oil acrid juice which turns black when comes in contact with air, if mixed with lime. The marking nut is also known as 'Bhilawan'. The resin contains semercarpol (monohydroxy phenol), bhilawanol (o-dihydroxy compound), fatty acids, tannic acids, etc. (Fig. 30.6).

Symptoms

When taken inside through mouth it produces blisters on throat and causes severe gastric irritation.

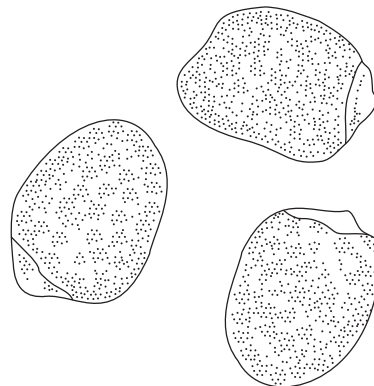


Fig. 30.6 Marking nut.

The stomach mucosa, and intestinal mucosa may be severely congested and inflamed. Ulceration may be seen. Dyspnoea, tachycardia, hypotension and finally death may occur.

Fatal Dose

More than 5 gm is sufficient to kill the person.

Fatal Period

12–14 hours.

Medico-legal Significance

When locally applied, it produces blisters on the skin followed by eczematous lesion. Accidental poisoning may occur. The juice is sometimes used as medicine for the treatment of syphilis by *hakims* and *vaidis*. The juice may be applied in vagina forcibly in cases of sexual jealousy. Homicidal poisoning has been reported. To implicate someone, juice is applied on skin or mucous membrane to produce blisters and ulcerations.

CALOTROPIS GIGANTEA AND C. PROCERA (MADAR)

The plants belong to the family Asclepiadaceae and is grown all over India. *Calotropis gigantea* has purple flowers while *C. procera* has white flowers. The active principles are uscharin, calatoxin and calatropin. When cut, stem and leaves of the plant exude an acrid milky juice. This juice is bitter in taste and acidic in reaction. When this juice is allowed to stand or heated, serum is exuded leaving behind white clot. The serum contains an active principle named gigantol which is very toxic.

Symptoms

When taken through mouth, *madar* juice produces burning pain in the throat and stomach. Salivation,

stomatitis, vomiting, diarrhoea, convulsions and finally death may be seen. When applied externally, it may produce local irritation and inflammation on the skin. If put in eyes, it may cause irritation and conjunctivitis.

Fatal Dose

Not known.

Fatal Period

Death may occur within 12–18 hours.

Treatment

Gastric lavage should be done immediately and later conservative treatment should be followed.

Medico-legal Significance

The *madar* plants are used as medicines adjunct. The flowers, leaves, root bark and milky juice are used. The flowers are used in stomach ailments as a tonic. The leaves are used as poultice over abdomen in colic. The root bark is used as an emetic. The milky juice is used as a vesicant, a depilatory and remedy in chronic skin diseases. *Madar* juice is used by tanners for removing hair from skin. It is also used for criminal abortion. It may be administered orally or used in abortion stick. *Madar* juice is sometimes used for killing infants. It is also used as a cattle poison and is thrust into the rectum of an animal by stick or cloth. The root of *C. procera* is used by snake charmers to control newly caught snakes as they cannot stand its smell. In Africa, both the plants are used in preparation of arrows and darts.

PLUMBAGO ROSEA (LAL CHITRA) AND P. ZEYLANICA (CHITRA)

The roots of these plants contain an active principle called 'plumbagin', a glycoside. It is a powerful irritant and has germicidal action. In small doses it acts as a sudorific and stimulates the contraction of muscles of heart, intestine and

uterus. In large doses, it causes respiratory failure leading to death.

Symptoms

When the roots are taken internally through mouth, it causes irritation of mucosa of stomach and intestine and later causes death due to narcotic action. Initially, there may be vomiting, burning pain in the stomach and diarrhoea. When applied externally, it causes irritation and blister formation.

Medico-legal Significance

The crushed roots are used for procuring criminal abortion. The paste of these roots are applied on abortion sticks. Juice of the roots can be applied locally to simulate bruise. Homicide is rare with these plants.

COLOCYNTH (BITTER APPLE/INDRAYAN)

It is the dried pulp of fruit of *Citrullus colocynthis* which is widely grown. The root and fruit contain a glycoside named colocynthin. It is bitter in taste

and acidic. This is a very strong purgative when taken in large doses.

Symptoms

The symptoms are severe abdominal pain, vomiting, severe diarrhoea and bloody stools leading to shock and death.

Fatal Dose

The fatal dose is about 1–3 gm.

Fatal Period

Death may occur in 24 hours.

Treatment

Gastric lavage followed by conservative supportive treatment.

Medico-legal Significance

It may be used for procuring criminal abortion or may be taken for suicidal purposes.

Irritant Poisons—Non-metallic Poisons (Inorganic)

MECHANISM OF ACTION

Irritant poisons act by causing inflammation in gastrointestinal tract. Symptoms usually start in 30 minutes to 1 hour after ingestion. There may be nausea, vomiting, burning pain and feeling of constriction in throat. There may be blood stained vomiting. Diarrhoea may follow. There may be pain and tenderness in abdomen. Slowly, the features of shock develop. Pulse may be weak and trendy. The blood pressure starts falling. Death may occur. Sometimes, features of irritant poison resemble diseases such as gastroenteritis, cholera, peritonitis or colic.

INORGANIC POISONING

It may be due to:

1. Non-metallic poisons
2. Metallic poisons

In this chapter non-metallic poisons are discussed.

PHOSPHORUS POISONING

Phosphorus occurs in two forms, namely yellow or white, and red. The yellow phosphorus is highly toxic. It is waxy, translucent and white. When exposed to air, it becomes yellow. It is not soluble in water. So, for preservation purposes, it is kept under water. When exposed to air, it emits fumes

of phosphorus trioxide as a result of oxidation. They have garlic-like odour. They are luminous in dark. The yellow phosphorus catches fire if temperature crosses 30°C. The yellow phosphorus was initially used in heads of Lucifer match box, but since 1931 its use in match box, industry was banned and red phosphorus is used nowadays. The yellow phosphorus is extensively used in chemical industry, fertiliser and rodenticide industry. It is also used in fireworks, gunpowder and incendiary ammunition.

Red phosphorus is prepared by heating yellow phosphorus at a temperature of 240°C in atmosphere of nitrogen or carbon dioxide. It has no taste or odour. It is stable at room temperature and is not oxidised as yellow phosphorus does. It is not poisonous. It is used in match box industry. It is not present on heads of match sticks but on sides of match box along with powdered glass. The heads of safety match sticks contain potassium chlorate and antimony sulphide.

Symptoms of Yellow Phosphorus Poisoning

The symptoms start appearing after a latent period of 1–6 hours after ingestion of yellow phosphorus. The symptoms starts with gastrointestinal system. There is a garlic-like taste in mouth, burning pain in throat and abdomen. There is intense thirst followed by vomiting. The vomited matter is garlicky in taste and is luminous in dark. The breath is also garlicky and may be luminous in dark. Diarrhoea may be present. In some cases, the

person may collapse because of circulatory failure when he has consumed a heavy dose. Acute yellow atrophy of liver is seen. The person may die due to shock, or later due to passage into coma.

In most of the cases, however, the person improves as symptoms subside. It may appear as though recovery has begun. But this is a latent period before liver complications begin.

Liver failure: Jaundice appears. Symptoms resemble acute viral hepatitis. Pruritus develops. The pain in stomach increases. Liver and spleen are enlarged and tender. Diarrhoea and vomiting become prominent. Haemorrhages may occur in mucous membranes like urethra, vagina and nose. Purpuric spots develop. The signs of hepatic failure appear.

The nervous system also starts getting affected. Restlessness, insomnia, impaired vision, and finally paralysis may be there. Circulatory collapse may be there. Pulse becomes rapid and irregular. Hypotension develops. The person may die of circulatory or nervous failure.

Mechanism of Action

Phosphorus is a protoplasmic poison. It disturbs cellular metabolism. Cellular oxidation is greatly affected and excessive fatty degeneration is seen. When comes in contact with skin, yellow phosphorus causes burns.

Fatal Dose

30–120 mg is the average fatal dose.

Fatal Period

4–10 hours if collapse occurs due to heavy doses otherwise it is about 2–7 days. Sometimes, 2–3 weeks may also occur before death.

Treatment

Gastric lavage should be done immediately with solution of potassium permanganate. It acts as an antidote by oxidising phosphorus present in the stomach to harmless compounds like phosphoric

acid and phosphates. Instead of potassium permanganate, solution of hydrogen peroxide may also be used. Charcoal may be administered later on.

The stomach can also be washed with warm water or 0.1 per cent solution of copper sulphate. It acts as a chemical antidote as it combines with phosphorus to form harmless copper phosphide. The patient should be given intravenous fluids and circulatory system should be managed with drugs. Morphine may be given to relieve pain. Dehydration should be taken care of with large amount of fluids. To restrict liver damage, low fat, high protein and high carbohydrate diet should be given.

Post-mortem Findings

On opening the body cavities, a garlic-like smell may be appreciated. The mucous membrane of stomach and intestine may be found congested, inflamed and perforations may be seen. The stomach contents may be garlicky in smell and luminous in the dark. Signs of liver failure may be seen. The skin may appear yellow. Haemorrhagic spots may be seen all over the body. The liver presents the features of necrobiosis. It may be enlarged. The liver appears yellow, and fatty degeneration may be seen. In acute yellow phosphorus poisoning liver atrophy, liver is smaller in size, greasy, leathery in character and yellow in appearance. The necrosis of liver cells is seen. The fatty degeneration may be seen in heart and kidneys.

Chronic Phosphorus Poisoning

It is rare nowadays. It occurs in workers who are exposed to fumes of yellow phosphorous. There is necrosis and sequestration of bones as a result of increased bone formation in the Haversian and marrow canals of bone, which is due to disturbance in the circulation of blood in bone. Even below the epiphyseal cartilage, bone formation is seen. The characteristic findings of chronic phosphorus poisoning are pain in teeth, failure of dental socket

to heal, and swelling and necrosis of jaw. Usually, lower jaw is affected. This is also known as **Phossy jaw**. The mucous membrane of mouth is congested. Besides these, pain in abdomen, nausea, vomiting, diarrhoea, jaundice and anaemia may be seen. Death may occur from debility.

Treatment

The person should be immediately removed from the source of fumes of yellow phosphorus. The teeth should be taken care of by removing causes and making supportive measures.

Medico-legal Significance

The phosphorus poisoning is rare now. People working in the industry may get affected accidentally. Some cases of suicidal and homicidal poisoning have been reported.

ORGANOPHOSPHORUS AND CARBAMATES POISONING

Organophosphorus compounds and carbamates are extensively used all over India as insecticides and miticide in agriculture. They are quite effective, cheap and easily available. Their quick action and easy availability are the factors that they are extensively used as suicidal poisons. Accidental poisoning is also very common in agricultural workers due to exposure.

The organophosphorus compounds are mainly of two types—alkyl phosphates and aryl phosphates. The common alkyl phosphates are HETP, TEPP, OMPA, Malathion, Systox, and Dipterex. The common aryl phosphates are parathion, Tik 20, chlorothion, etc.

The common preparations of carbamates are Baygon, Kevin 50, carbaryl, carbendazim, carbofuran, etc.

Mechanism of Action

They are absorbed from skin, respiratory, gastrointestinal and circulatory systems very easily.

Acetylcholine is a neurotransmitter that affects preganglionic and postganglionic parasympathetic, synapses (muscarinic actions), sympathetic preganglionic synapses including the adrenal medulla (nicotinic actions) and the neuromuscular junctions (nicotinic actions). At the synapses it is hydrolysed by the enzyme acetylcholinesterase. The toxic effects of organophosphorus compounds and carbamates are due to inhibition of activity of acetylcholinesterase. As a result, there is accumulation of acetyl choline at the synapse. This initially stimulates and later paralyses the cholinergic transmission in CNS, autonomic ganglia, parasympathetic nerve endings, sympathetic nerve endings at sweat glands and neuromuscular junction.

Symptoms

Carbamates cause less morbidity and mortality as they cause transient inhibition of cholinesterase as compared to organophosphorus compounds. Toxic effects of carbamates on central nervous system are not much prominent as they do not penetrate the central nervous system as effectively as organophosphorus compounds. The accumulated acetylcholine causes following symptoms:

1. **Muscarinic Features (Parasympathetic Features):** Anorexia, nausea, vomiting, abdominal cramps, colic, sweating, salivation, bronchial spasm, increased bronchial secretion, pupillary constriction, defective vision and cyanosis. Hypotension and bradycardia may be seen.
2. **Nicotonic Features (Somatic Motor and Sympathetic Nerve Endings):** Muscle fasciculations, muscle cramps, fatigue, loss of deep tendon reflexes, paralysis, tachycardia, hypertension and rarely mydriasis.
3. **CNS Features:** Severe headache, tremors, restlessness, ataxia, weakness, confusion, slurred speech, coma, convulsions and depression of cardiorespiratory centre. Other features of poisoning are:

1. An acute garlic odour may be seen but it is also seen in arsenic and phosphorus poisoning.
2. *ECG features:* ST-T changes are seen. A low voltage of QRS is seen.
3. *Uncommon manifestations:* Hyperglycaemia may be seen in 7–10 per cent cases, hyperamylasaemia and clinical acute pancreatitis may be seen. Hypoglycaemia may also be seen. Changes in ECG include AV dislocations, idioventricular rhythms, ventricular extrasystole, increased PR, QRS and QT interval.
4. Weakness of upper extremities and neck musculature may be seen. Cranial nerve palsy may be seen.
5. Delayed neuropathy may be seen after 10–21 days. It is mainly seen in organophosphorus poisoning. It starts distally and progresses proximally. Paraesthesia and motor weakness may be seen.
6. The sequelae of organophosphorus poisoning include myonecrosis, delayed neuropathy, personality changes, depression, confusion and thought disorder.
7. If there is exposure to organophosphorus compounds within first trimester of pregnancy, congenital malformations may be seen. If ingested later in pregnancy, it may cause spontaneous labour.

Confirmation Test (Laboratory Methods)

If erythrocyte cholinesterase levels are reduced below 50 per cent and symptoms are present, the diagnosis is confirmed. Plasma pseudocholinesterase levels can also be assessed and would be found to be reduced. These enzyme levels may also be reduced in chronic liver disease, malnutrition, infections and anaemias. In carbamate poisoning, the measurement of these tests is unreliable as enzyme activity returns to normal within a few hours.

Fatal Dose

The organophosphates can be classified according to toxicity:

1. **Mild Toxic:** Chlorothion and malathion are mild toxics as fatal dose is more than 25 gm.
2. **Moderately Toxic:** Diazinon has a fatal dose of 10–25 gm.
3. **Highly Toxic:** The fatal dose is less than 5 gm. Examples are parathion (15–30 mg), methyl parathion (15 mg) and TEPP (5 gm).

Fatal Period

Symptoms start within 30 minutes and death may occur within 4 hours. In non-fatal cases, effects may last for 30–72 hours.

Treatment

The person should be removed from the source of exposure. All his clothes have to be taken off and exposed areas should be cleaned with water or soap to remove all unabsorbed poison present on the skin. The airways should be immediately secured, breathing and circulation to be maintained. Gastric lavage should be started immediately with 2 per cent solution of potassium permanganate. Sodium sulphate may also be given.

Antidotes

Atropine blocks muscarinic and CNS manifestation of the poison but has no effect on nicotinic effects. Initially, atropine is administered in a dose of 2–4 mg for adults and 0.05 mg/kg for children. The same dose should be repeated every 5–15 minutes till signs of atropinisation appear in form of dry skin, dilated pupils and tachycardia. The atropine should be continued till oral and tracheal secretions stop. Do not consider the dilatation of pupils as the end point. It is reached when he cannot spit. After the end point is reached, administer atropine in small doses at less frequent intervals to maintain atropinisation for 24–48 hours. If excess dose of atropine is given, it may produce delirium and fever.

Specific Reactivator Oximes

PAM or pralidoxime can be used as it is a cholinesterase reactivator which primarily counters the nicotinic effects of organophosphates, though it can also reverse some of the CNS effects. Since it generates acetylcholine at all levels, it can be effectively used. It is very effective if it is used early. In adults, PAM can be administered in a dose of 1–2 gm slow intravenously over 10–20 minutes while in children the dose is 25–40 mg/kg. The dose is repeated 4–8 hours. PAM is contraindicated in carbaryl (carbamate) poisoning. In other carbamates, the role of PAM is not clear. Since the duration of action of carbamates is short, PAM is not required. Renal function should be adequate when PAM is given.

Besides above, electrolyte balance, hydration and nutrition should be taken care of. Ventricular arrhythmias should be managed. The most common cause of death is respiratory failure.

Post-mortem Appearance

The findings suggest asphyxial death. The face is found to be congested and blood-stained froth may be seen. The stomach wall is found to be congested. The stomach contents have a smell of kerosene. The lungs are found to be congested and oedematous. The pulmonary oedema is seen. Brain is congested and petechial haemorrhages may be seen in brain, heart and stomach.

Medico-legal Importance

The organo-phosphates and carbamates are extensively used by farmers to commit suicide as they are easily available and very effective. In India, in many states like Andhra Pradesh and Punjab many farmers committed suicide by these poisons due to inability to pay loans.

Accidental poisoning is very common in agricultural workers who spray them in fields. Protective clothings like white overall, rubber gloves, rubber boots, eye shields, dust masks, respirators, etc., should be used by these workers.

The spraying should not be done for more than 10 hours. The person should change clothes and take bath after the spraying is over.

Accidental poisoning among children is common when they put poison in their mouth accidentally while playing in fields sprayed by organophosphates.

Homicidal poisoning is very rare as very bitter taste of these compounds make them unfit as homicidal poisons. Kerosene-like smell cannot be masked even when mixed with food although small children can be given poison forcibly by mouth to kill them.

Aluminium Phosphide Poisoning

Aluminium phosphide poisoning has increased like jungle fire since the last decade. Aluminium phosphide is used as grain preservative all over India. In the market it is available in 3 gm pellet containing 57 per cent aluminium phosphide, rest being ammonium carbonate. The common names of commercial preparations are Celphos, Alphos, Quickphos, Synfume and Phosfume. The usual procedure of storage is that after grains are deposited in godowns, pellets of aluminium phosphide are kept in between and godowns are sealed. Phosphine gas is liberated which kills any pests or rodents which manage to sneak into godowns and thus get killed. Once the grains are needed for consumption, godowns are opened and the grain is exposed to sunlight, the phosphine gas present in the grain is liberated into atmosphere and the grain is suitable for human consumption. The non-toxic residues like phosphite and hypophosphite of aluminium are left in the grain which can easily be removed.

Mechanism of Toxicity

Once the pellets of aluminium phosphide enter the stomach due to ingestion, phosphine is liberated due to action of water on pellet there. This phosphine gas is absorbed and produces the deleterious effect. A part of aluminium phosphide

is also absorbed directly and is metabolised in liver with a slow release of phosphine. It causes prolonging of symptoms. Phosphine thus liberated binds to cytochrome oxidase and causes widespread organ damage. Focal myocardial necrosis is caused leading to cardiotoxicity.

Symptoms

The symptoms of aluminium phosphide poisoning can occur either due to ingestion of pellet or inhalation of phosphine gas. In both circumstances, symptoms are the same. If a pellet of aluminium phosphide is exposed to environment for a long time, it becomes useless as, due to environmental moisture phosphine is liberated into the atmosphere. The poisoning symptoms can be classified as mild and moderate to severe.

Mild Poisoning

Irritation of gastrointestinal tract and respiratory distress are the main features. Dizziness, fatigue, nausea, vomiting, diarrhoea, headache and tightness in chest are commonly seen.

Moderate Poisoning

Besides above, diplopia, ataxia, tremors and paraesthesiae are seen.

Severe Poisoning

Adult respiratory distress syndrome (ARDS), cardiac arrhythmias, convulsions, coma and death are seen.

Hypotension, shock, tachycardia and sometimes bradycardia may be seen. Congestive heart failure occurs due to myocardial depression. Atrial fibrillation, premature beats, A-V junctional tachycardia, and conduction defects are seen in ECG recording along with occasional ST segment elevation. Acute pericarditis has also been reported.

Within 6–36 hours, respiratory symptoms like dyspnoea, cough, cyanosis and ARDS are seen.

Consciousness is retained till the end in most of the cases. Metabolic acidosis is seen.

Fatal Dose

One pellet of aluminium phosphide is sufficient to kill an adult person. Even less than 500 mg of unexposed pellet is a lethal dose. Inhalation of phosphine at a level of 400–600 ppm is lethal.

Fatal Period

It ranges from 30 minutes to few hours. Sometimes, death may be delayed for a few days if the person is hospitalised.

Treatment

There is no antidote available for poisoning due to aluminium phosphide or phosphine gas. The whole treatment is conservative. A gastric lavage with potassium permanganate should be done. The lavage oxidises the liberated phosphine into a non-toxic phosphate. Activated charcoal may be given as it adsorbs phosphine gas.

The magnesium sulphate infusion is very helpful in reducing the toxicity to various organs. It reduces cardiac arrhythmias. The dose is 3 gm bolus followed by 6 gm infusion over 12 hours for 5–7 days.

Since phosphine is excreted through lungs and kidneys, renal function should be maintained by giving intravenous fluids. The patient should be maintained on supportive treatment. Mortality is very high as aluminium phosphide is very toxic.

Laboratory Test

Silver nitrate test can be done to confirm the presence of aluminium phosphide in vomitus, lavage fluid or in the breath.

Procedure

Take 1 ml of vomitus or lavage fluid in a test tube and dilute it by adding 15 ml of water. Take two round strips of filter paper impregnated with silver nitrate. Place one on the mouth of the test tube and the other on open surface. Slowly heat the test tube to 50°C for 15–20 minutes. If aluminium

phosphide is present in the fluid, phosphine would be liberated and it will darken the filter paper by producing silver. The other strip is kept in open as a control.

If you want to test the presence of phosphine in breath, keep the filter paper impregnated with silver nitrate as a mask. Ask the patient to breathe for 15–20 minutes. If phosphine is present, the filter paper would turn dark due to production of silver.

Post-mortem Appearance

There are no specific findings present. Congestion and haemorrhages may be seen in gastric mucosa and intestinal mucosa.

Medico-legal Significance

Aluminium phosphide poisoning is increasing as farmers all over India are using it as a preservative. The aluminium phosphide pellets are easily available and are quite cheap.

Suicidal poisoning is very common in rural India by aluminium phosphide. Since it is kept in homes, wives or children may also use it for suicidal purposes.

Accidental poisoning is also common as a farmer may sleep near godown and may die of the leaking phosphine from godown where it has been kept as a preservative.

Accidental poisoning is also reported in children who may eat it by mistake.

Homicidal poisoning in adults is not reported but small children may be killed by forcible ingestion of pellets or giving them in food.

PYRETHRINS AND PYRETHROIDS

Pyrethrins are derived from plant chrysanthemum. Pyrethroids are synthetic compounds which are commonly used as “knockout” for mosquitoes and other insects. The common pyrethrins and pyrethroids are allethrin used in Baygon mats, D-allethrin (used in Goodnight mats, Hit insect repellent and pyrethrum (Tortoise mosquito coil). These compounds are used as insect repellent, in pest control.

Since these compounds can easily be metabolised by human beings, they are not toxic but can produce allergic and other reactions when taken in large doses. The common symptoms are dermatitis, itching, eye irritation and rhinorrhoea and nasal irritation. In large doses they can produce nausea, vomiting, paraesthesias, seizures, fasciculations and coma. Treatment includes skin decontamination by washing with soap. Eyes should be cleaned with water. In massive ingestion, gastric lavage is useful. The rest of the treatment is symptomatic.

Irritant Poisons—Metallic Poisons (Inorganic)

ARSENIC

Arsenic in nature, is found in metal form, inorganic compound and organic compound.

Metallic Arsenic

Arsenic in metal form is not poisonous as it is insoluble in water and hence cannot be digested by alimentary canal. But when metal arsenic is exposed to air, it becomes toxic. When heated, arsenic readily combines with oxygen in the air and forms poisonous arsenic trioxide. On local application, arsenic may enter the skin after oxidation in the air and may cause local necrosis.

Inorganic Compounds of Arsenic

The following inorganic compounds are commonly seen:

1. **Arsenic Trioxide:** The chemical formula is As_2O_3 . It is commonly known as *Sankhya* or *Somalkhar*. It is white, crystalline powder, odourless and tasteless. It is almost insoluble in water and comes up as a thin layer above water when mixed. In nature it is found as an impurity in iron and sulphide ores. Arsenic trioxide or arsenious oxide is extensively used in dyeing, preparation of wall papers and artificial flowers, calico printing and arts. It is the main constituent

of fly papers and many powders used for killing rats. It is also used for preserving timber and skins against white ants. It is also widely used as medicinal preparation liquor arsenicalis (Fowler's solution) containing one per cent arsenious oxide. It is also used by *hakims* and *vaidis* in treatment of various diseases like skin disorders, rheumatism, impotence and fevers.

2. **Arsenites:** When arsenic trioxide combines with alkalies and their carbonate or other metals, arsenites are formed. The alkaline arsenites are soluble in water. They are more toxic than arsenates.

Potassium arsenite, sodium arsenites: They both are very toxic. They are used in manufacture of flypapers, weed killers, rodenticide, fungicides and sheep-dips. Copper arsenite (Scheele's green) and copper acetoarsenite (Paris green) were extensively used for colouring artificial flowers, wall papers, toys, dress article and sweetmeats. But they have been replaced by aniline dyes. They are sometimes used as rodenticide.

3. **Arsenates:** When arsenic acid combines with metal, arsenates are formed. The arsenates of alkaline metals are soluble in water. Rest are not. The chief arsenates are sodium arsenates and potassium arsenates.

Both of these salts are toxic and are used for homicidal purpose and for killing cattle.

4. **Arseniuretted Hydrogen:** It is formed by action of nascent hydrogen on a soluble arsenic compound. It is liberated in industries involving galvanising, soldering, etching or lead plating. It is very poisonous and has a garlicky odour. It burns with bluish white flame. It is a haemolytic poison.

Organic Compounds of Arsenic

These compounds are formed when arsenic combines with big organic groups. Most of the compounds were used in medicine but now they are not used. Common are cacodylic acid, sodium cacodylate, atoxyl, salvarsan, neosalvarsan and sulpharsenobenzene. They are less toxic as compared to inorganic salts.

Acute Poisoning

The symptoms of acute poisoning occur within 30 minutes of the exposure. First, there is usually a metallic taste in the mouth and a slight smell of garlic in breath. Dry mouth and dysphagia are seen. Severe nausea, vomiting, colicky abdominal pain and profuse diarrhoea with rice water stools start abruptly. Bloody diarrhoea may also be seen. All arsenic compounds inhibit sulphhydryl enzyme system which are necessary for cellular oxidation.

Arsenic is a very potent capillary poison. It dilates capillaries and causes damage. This leads to generalised vasodilatation and transudation of plasma and causes shock. Intense thirst and severe vomiting may be seen. The urine is suppressed. Slowly the person goes into shock. The eyes are sunken. The pulse is feeble and irregular. The death occurs due to hypovolaemic shock.

If a very large dose is taken, death may occur rapidly from shock without producing any symptoms. Sometimes, when a large dose is taken, it may induce vomiting and it may be possible that all poison is vomited out even before absorption. So, the person's life may be saved (Table 32.1).

A sensorimotor peripheral neuropathy may develop within few hours of congestion but it is usually seen 2–8 weeks after ingestion. In severe cases, the patient may have quadriplegia and may die due to respiratory failure as a result of involvement of muscles. Cardiac manifestations include acute cardiomyopathy, subendocardial haemorrhages and ECG changes. Prolonged QT interval and nonspecific ST-T changes may be seen. Hyperpyrexia and haemolysis may also be seen.

Sub-acute Poisoning

When a small quantity of arsenic is administered slowly at a repeated intervals to cause death, it is called a sub-acute poisoning. In this case, death is

Table 32.1 Differences between arsenic poisoning and cholera

<i>Symptoms</i>	<i>Arsenic poisoning</i>	<i>Cholera</i>
1. Pain in throat	May be there before vomiting starts	Not there
2. Voice	No change	Peculiar, rough and whistling
3. Conjunctiva inflammation	May be seen	Not there
4. Vomiting matter	Contains mucus, bile and blood may be there	Watery
5. Purging	Follows vomiting	Precedes vomiting
6. Motions	Rice water in appearance but may be blood stained	“Rice water” in appearance, liquid, white discharge
7. Laboratory examination	Barium-like radiopaque shadow may be seen on X-rays Arsenic detected on chemical analysis, urinary coproporphyrin may be positive	Cholera vibrio may be seen and cultured

caused slowly and may appear as natural death due to illness. The symptoms are dyspepsia, cough and tingling in the throat at first, then vomiting, purging with abdominal pain and tenesmus occurs. The motions become bloody. The symptoms of neuritis are more marked. The patient complains of severe pain in muscles which are quite tender. The death occurs due to failure of respiratory muscles. In non-fatal cases, paralysis may be seen.

Acute Poisoning by Arseniuretted Hydrogen

This gas when absorbed through lungs, immediately acts as direct poison to haemoglobin of red blood cells. It causes haemolysis leading to jaundice. Faintness, giddiness, intense headache, nausea, vomiting, abdomen pain, anuria and uremia may be seen. Soon, dyspnoea, cyanosis and collapse may set in. Death may occur due to coma or respiratory failure.

After 2–4 weeks of acute ingestion of arsenic, hair loss may be seen along with **Mees's lines** on the nails. They are white transverse bands seen in the nailplate. These lines may remain up to one year.

Fatal dose: About 180 mg of arsenic trioxide is a fatal dose. The fatal dose of arseniuretted hydrogen in exposure limit of 30 minutes–1 hour in concentration of 1 part gas in 20,000 parts of air. *Fatal period:* The average fatal period is 12–48 hours.

Diagnosis: Acute arsenic poisoning may be confused with cholera where same features may be seen. Table 32.1 shows how to differentiate the two.

Treatment: Gastric lavage must be started at once. It should be done with plain water first, then freshly prepared hydrated ferric oxide may be given in oral doses so as to convert arsenic trioxide into harmless ferric arsenite. If it is not available, activated charcoal may be given. Adequate intravenous solutions should be given to manage shock. An exchange transfusion may be of help in clearing arsenic from blood in early stages. Hemodialysis, if available, can be done. Chelation

therapy is very useful. Dimercaprol (BAL) should be administered in a dose of 3–5 mg/kg intramuscularly every 4 hours. This dose should be tapered off but administration of BAL should be continued till the urinary excretion is less than 50 µgm every 24 hours. Penicillamine has also been found to be useful in some cases. Recently 2,3-dimercaptosuccinic acid is used which can be given orally and is quite useful.

In the treatment of arseniuretted hydrogen, the person should be treated with fresh air and oxygen inhalation. Early exchange transfusion or hemodialysis can be done. BAL is not much effective in the treatment.

Post-mortem Findings

The characteristic finding is that the rigor mortis lasts longer than usual. Due to dehydration, the body may show features like sunken eyeballs and it may appear to be shrunken. In internal appearances, stomach mucosa may show gross congestion and is found covered with particles of arsenic embedded into it along with mucus. The petechial haemorrhages may be seen. It must be remembered that arsenic may be found in stomach even if it has been given by any route other than oral, as arsenic is re-excreted in the stomach and intestine. Ulceration may be seen. The small intestine is also found to be congested into large flakes of mucosa. The liver, spleen and kidneys are congested. Petechial haemorrhages may be seen in heart, lungs, liver and brain. In poisoning by arseniuretted hydrogen, the skin colour may be yellow. The mucous membrane of stomach and small intestine may be yellow coloured and inflamed. Oedema may be seen in lungs.

Chronic Poisoning

It usually occurs in workers involved in smelting and refining of ores, in the subliming of white arsenic in the manufacture of sheep-dips, weed killers, insecticides, paints, dyes, etc. It has also been reported in patients who have been taking medicines containing arsenic for a long time.

Sometimes, chronic poisoning develops following acute poisoning when a large dose has been taken.

Symptoms

There are four stages described:

First stage: Mainly gastrointestinal symptoms like loss of appetite, salivation, colicky pain, constipation or diarrhoea and vomiting. Marked weight loss may be seen. The tongue may be coated with white, silvery fur. Mild fever may be seen.

Second stage: Generalised or localised finely mottled pigmentation of skin diffuse in nature or rain drop-like patchy appearance may be seen. Skin toxicity is seen as persistent erythematous flush leading to hyperkeratotic skin and desquamation. Hyperkeratosis is most prominent in the distal parts of the body. A diffuse desquamation of palms and soles is seen. The nails become brittle and show linear pigmentation in the form of **Mees's lines**. Perforation of nasal septum may be seen. Dryness is commonly seen in throat and larynx. Voice becomes hoarse. Photophobia with conjunctival congestion may be seen. Liver may be enlarged or become cirrhotic.

Third stage: In this stage, sensory symptoms predominate. Muscle cramps, muscle weakness, arthralgia and marked tenderness of body muscles may be seen. Knee jerks are absent. Impotence may be there. Bone marrow depression and anaemia are seen. There is an interference with absorption of folic acid.

Fourth stage: Peripheral neuropathy and muscular atrophy are seen. There is marked muscular weakness, ataxia and atrophy of the extensor muscles leading to "wrist drop" and "foot drop". The interossei and intercostal muscles are affected. Anaemia and leucopenia are there. Anaemia is normocytic and normochromic, and is

caused as a result of haemolysis. Karyorrhexis an accelerated pyknosis of the normoblast nucleus is characteristic and is manifested by bizarre nuclear forms seen on bone marrow examination. Basophilic stippling may also be seen. Megaloblastic anaemia picture may emerge due to folate metabolism interference. Respiratory muscle involvement may lead to death.

Treatment

Patient should be removed from the source of poison. BAL must be administered intramuscularly six hourly for 2–3 days, then one per day. Early treatment help reducing the harmful effects in toxic encephalopathy. Vitamins should be given to take care of peripheral neuritis. General measures should be initiated to take care of health.

Poisoning by Organic Compounds of Arsenic

The organic compounds of arsenic are either in trivalent or pentavalent form of arsenic. They are less poisonous than inorganic compounds of arsenic. The main clinical features are anaphylactic reaction, skin reaction, hepatitis and jaundice. Optic atrophy is seen in pentavalent compounds. Encephalitis may be seen. These compounds are generally administered intravenously. Fatty degeneration of liver may be seen on post-mortem appearance. In chronic poisoning, peripheral nerves may show fragmentation on microscopic examination.

Chemical Tests of Arsenic

Reinsch's Test

It may detect arsenic in very low doses up to the extent of one in seven million part.

Procedure: Bright copper foil is kept in the suspected solution which has been acidified by adding hydrochloric acid and is boiled for 10 minutes. The copper foil would be coated steel grey

or black due to deposit of arsenic if present. The foil is then removed. It is washed successively with water, alcohol and ether, dried on filter paper and then heated by placing it in a small test tube. The deposit, if it is due to arsenic, will evaporate and will form a white deposit in cooler position of the tube. If this deposit is seen under a microscope, octahedral crystals of arsenious oxide would be seen.

Marsh's Test

This is also a very delicate test that can detect arsenic in very small concentration.

Procedure: This test is based on formation of arseniuretted hydrogen when compounds of arsenic except metal and its sulphide are brought in contact with nascent oxygen. In this, suspected mixture of arsenic is put into Woulff's tub which is a hydrogen generating bottle in which zinc and dilute sulphuric acid are dropped. This tub is connected to a long glass tube which ends in a jet. When nascent oxygen comes out, a flame can be applied and it would burn with pale blue flame. If arsenic is present in the mixture, arseniuretted hydrogen would be formed and it would burn with a bluish or greenish violet or purple colour. Garlic-like odour may also be appreciated. A control test must be run to avoid wrong results as sometimes zinc and sulphuric acid may have arsenic as impurity.

Gutzeit Test

The suspected solution is kept in a large test tube with pure zinc and sulphuric or hydrochloric acid containing potassium iodide to colour it yellow as to remove sulphur oxide and hydrogen sulphide if formed. The mouth of the tube is covered with a filter paper moistened with silver nitrate. If arsenic is present in the suspected solution it would turn yellow owing to formation of a double compound of silver arsenide and silver nitrate. If water is added. The yellow colour becomes black by separation of silver. In modified Gutzeit test, the filter paper is permeated with mercuric chloride instead of silver nitrate. It produces yellow stain. It turns red if hydrochloric acid is put on it.

Medico-legal Significance of Arsenic Poisoning

The medico-legal significance of arsenic poisoning is as follows:

1. **Whether Poisoning is Suicidal, Homicidal or Accidental:** Arsenic is widely used for homicidal purpose all over the world as it is cheap, easily available and can be easily mixed with food as it does not mask the smell and taste of the food. Sometimes, low doses of arsenic are given slowly over a long period of time so that death of the person may appear to be natural. Many wives have got rid of their husbands by this method. Many big political leaders and kings have been poisoned slowly by mixing arsenic in their food.

Arsenic is less used for suicidal purpose as the person may survive even with large doses. In some cases the person may survive even with fatal dose as the poison may come out completely in vomitus. Arsenic is also used as an abortifacient both with internal administration and with local application in the form of a paste on a stick. Most of such abortions are criminal ones, done by local quacks. Accidental poisoning with arsenic is also common, in workers in industries where arsenic is used. Accidental poisoning can occur in children if they consume fly papers. Accidental poisoning can occur if a medicine containing arsenic has been taken for a long time. Poisoning by arseniuretted hydrogen is generally accidental in industrial workers.

2. **Tolerance to Arsenic:** Some people like *sadhus* consume arsenic on a daily basis and are called *arsenophagists*. These people get tolerance to high levels of arsenic. Some people in India consume arsenic on regular basis as aphrodisiac, although this perception is wrong. Some people take arsenic thinking that it would improve their

looks and health but it too, is not correct. All these people suffer from mild chronic arsenic poisoning.

3. **Elimination of Arsenic:** Arsenic is eliminated from body through urine, stools, hair and nails and to some extent through sweat, saliva, bile, bronchial secretion and milk. If we can divide hair into successive lengths from root upward and analyse them separately, we can get information regarding the time elapsed since arsenic had been given. If arsenic is not given during certain period, it would not appear in the length of hair formed in that duration of time. The growth of hair is about one cm in 28 days. From that we can calculate the time when the arsenic was given. By neutron activation analysis of hair, we can find out the amount of arsenic ingested during that time.
4. **Deposition of Arsenic:** Arsenic gets deposited in bones due to conversion of the phosphates present in the bones into arsenates. So, it is very essential that long bones must be preserved if chronic arsenic poisoning is suspected. In acute poisoning, the arsenic gets deposited in liver. The greatest concentration of arsenic is seen in hair and nails where it is stored permanently. Hair and nails must be preserved in any suspected arsenic poisoning.
5. **Effect on Decomposition:** It has been found that arsenic retards decomposition and as a result, the body remains preserved for a long time.
6. **Post-mortem Imbibitions:** Arsenic is not a normal constituent of body although it is commonly present in ground water, vegetables and soil. It is possible that once dead body is buried, some amount of post-mortem imbibition may start. In all cases of exhumation, control samples of soil from above, below and sides of the dead body should be taken for comparison of arsenic levels found in it, if any, although post-mortem

imbibition is not so much as to produce signs of ulceration and congestion in the stomach which is a vital ante-mortem sign.

MERCURY

The mercury exists in three forms: metal, inorganic salt and organic salts. The inorganic salts are mainly mercurous and mercuric salts while organic salts are alkyls and aryls. Mercuric salts are more toxic than mercurous salts.

Elemental Mercury

It is a liquid metal, silvery lustre, volatile at room temperature. Its fumes are odourless and invisible. It is used in making thermometers, barometers, mercury vapour lamps and in electrical industry. It is also used in gastroenterology equipment.

Clinical Features

When elemental mercury is ingested, it is not absorbed well by the gut. It is seen that ingestion of elemental mercury is not at all harmful to the body except some local irritation. Mercury may get stored in appendix, which may later inflame and appendicectomy may be required. On X-ray examination, mercury can be seen as small, rounded, opaque globules of diameter less than 3 mm. Systemic toxicity can only occur if there is an injury in gastrointestinal tract. Some ointments contain elemental mercury. If these ointments are applied in heavy doses all over the body, systemic toxicity can occur. The clinical features are headache, vertigo, followed by generalised itchy lesions, fever and gingivo-stomatitis.

The mercury poisoning can occur through inhalation when the metal is heated in a closed room just as in gold ore purification. The symptoms include dyspnoea, cough, fever, nausea, diarrhoea, abdominal cramps, chest pain and blurring of vision. There is a metallic taste in the mouth. If it continues, pulmonary involvement may be there. There may be pneumonia, pulmonary oedema and

death. The chronic inhalation of mercury may cause painful extremities commonly called acrodynia. There may be anorexia, weight loss, irritability, redness of fingers and photophobia.

Sometimes, mercury may enter circulation by mistake in clinical practice through intravenous injection while taking arterial blood gas sampling with syringes which contain elemental mercury as seal. Peripheral mobilisation may be seen and gangrene may be observed in distal phalanges where mercury is lodged.

Treatment

If elemental mercury is ingested, laxatives are given and X-rays are repeated after 2–3 days. It takes about 6 weeks for the mercury to leave. In local application, chelation therapy with BAL and D-penicillamine may be done if toxicity is seen. In inhalation, treatment is supportive and chelation can be done, if required.

Inorganic Salts of Mercury

The common compounds of inorganic salts of mercury which produce toxicity are as follows:

1. **Mercuric Oxide:** It is red or yellow crystalline powder. It is insoluble in water.
2. **Mercuric Chloride:** It is also known as corrosive sublimate. It is heavy, colourless mass of prismatic crystals or a white crystalline powder. It is used as an antiseptic quite commonly in clinical practice, and is applied on cuts, abrasions, etc. When ammonia is added to a watery solution of mercuric chloride, ammoniated chlorine of mercury is produced which is used in preparation of some medical ointments.
3. **Mercuric Sulphide:** It is the chief ore of mercury and is artificially prepared as red powder, which is commonly known as **sindoor or vermilion pigment**. It is commonly used by women in India on head as a religious practice of married women. It is considered as non-poisonous.
4. **Mercuric Sulphate:** It is white in colour and acts as a corrosive.
5. **Mercurous Chloride:** It is sold in market as *vas Kapoor*. It is heavy, white mass often mixed with mercuric chloride. Previously it was used as teething powder of young children.

Fatal Period

3–5 days.

Fatal Dose

1–4 gm is fatal dose for mercuric chloride. Local application of 7–10 gm of mercuric oxide on open lesions is fatal.

Clinical Features

Inorganic mercurial compounds produce toxicity by ingestion, inhalation or absorption through skin. These compounds do not cross blood-brain barrier. Kidneys and colon are the worst affected. Corrosive action on alimentary canal causes nausea, vomiting, burning, and necrosis. Acute renal failure sets in. The person may die due to fluid loss and shock. Acute pulmonary oedema, coma, muscle tremors and generalised hypertonia may be seen. In pregnant women, abortion may occur. In neonates, renal, dysfunction, cataract and anaemia may be seen. Gangrenous colitis may be seen after 6 days.

Laboratory Diagnosis

Toxic blood mercury levels are seen as 3 mg/dl and urinary levels up to 100–300 mg/l.

Treatment

Gastric lavage is indicated. Administer milk or egg white and later activated charcoal may be given. Chelation therapy with BAL or penicillamine is the main treatment. Hemodialysis and peritoneal dialysis is quite useful. Plasma exchange can also be

considered. If renal failure is seen, chelation therapy is not much useful. In such cases Extra corporeal Regional Complexing Hemodialysis (ERCH) is quite useful. In this, chelating agent DMSA (2,3-dimercaptosuccinic acid) is injected into arterial bloodline of the dialyser. It causes redistribution of metal from protein binding sites to a complexed diffusible form which readily passes through the dialyser membrane. So, both metal complex and chelating agent are removed from the body.

Post-mortem Findings

The corrosive action would be seen in the alimentary canal if a large dose is given; otherwise symptoms of irritant poisoning would be seen. The large intestine, caecum, colon and rectum are found inflamed and ulcerated, and may show gangrene if the patient has lived for some days. Liver, spleen and kidneys are congested. The stomach may show congestion, necrosis or even perforation. Post-mortem lesions in alimentary canal are seen even in those cases where the corrosive sublimate has been given by external route.

Chronic Poisoning

Chronic poisoning occurs in factory workers who are exposed to vapours or dust of mercury while working. It is also seen in patients who use ointments for a long time which contain mercury. Blood levels above 100 µgm per 100 ml of blood are indicative of poisoning.

Symptoms

Abdominal symptoms like nausea, colic pain and vomiting are seen. A brownish blue line is seen in gums at the junction of teeth. The swollen gums, painful salivary glands, bad mouth odour and necrosis of jaw may be seen. Other symptoms are:

1. **Mercuria Lentis:** A brownish reflex from anterior lens capsule of both eyes when seen through slit lamp, called mercuria lentis is observed. It is due to brownish deposit of mercury on anterior lens capsule. Skin

eruptions of erythematous and eczematous nature with some thickening of skin of hands and feet are seen.

2. **Mercurial Tremors or Hatters Shake Tremors:** These are coarse tremors seen on fingers first and tongue later. The stammering or hesitation of speech is seen. Later, the tremors develop in muscles of face, arms and legs. These tremors are absent while asleep. They are increased when voluntary movements are done. Movements are incoordinated. Peripheral neuritis may be seen.
3. **Erethism:** These are mental symptoms which develop in workers in factories producing mirrors. The person may be irritable, mentally depressed, loss of memory found, and, he may be mentally confused. Hallucinations may be seen followed by insanity.

Treatment

The workers should be removed from the surroundings immediately. The dental hygiene should be taken care of. Chelation therapy with BAL is quite useful.

Organic Compounds of Mercury

The organic compounds of mercury are of two types: aryl and alkyl mercury compounds. The aryl mercury compounds are degraded into inorganic mercury in the body while alkyl mercury compounds remain as organic compounds.

Clinical Features

Poisoning by organic compounds of mercury produces following clinical features:

1. **Methyl Mercury:** It is used as fungicide. It is absorbed from gastrointestinal tract completely. The main features are CNS symptoms like neuropathies, inco-ordination, tunnel vision, mental deterioration, hearing loss, tremors, and

finally coma. Local application may produce dermatitis and irritation.

2. **Ethyl Mercury:** In addition to the above, renal damage and gastrointestinal symptoms are seen.
3. **Phenyl Mercury:** The common route is oral ingestion. It produces symptoms that resemble inorganic compounds poisoning.
4. **Mercurochrome:** It is widely used in clinical practice as it has bacteriostatic properties. It was previously given in controlling infection by intravenous route. It can cause acute nephritis, intestinal lesions, fever and death.

Treatment

The treatment of organic mercurial compound is mainly supportive. Chelation therapy is not useful in methyl mercury poisoning. In cases of aryl mercury compounds, chelation therapy is useful. Penicillamine is more effective than BAL in such cases.

COPPER

The copper salts act on the body by precipitating proteins. The following salts are important from medico-legal point.

1. **Copper Sulphate:** It is also commonly called *Nila thotha* or blue vitriol. The chemical formula is CuSO_4 . It is blue crystalline powder freely soluble in water having a styptic taste. It can be given as an emetic in low doses but it is an irritant when given in large doses.
2. **Copper Carbonate:** It occurs in malachite in nature. It is obtained when carbonate of sodium is added to a solution of copper sulphate.
3. **Copper Subacetate:** It is frequently used in medicine and arts.

Acute Poisoning

Symptoms start within 15–30 minutes of consumption. There is severe vomiting, nausea, thirst, metallic taste in mouth, burning pain and

salivation. The vomited matter is blue or green in colour and it can be differentiated from bile by addition of ammonium hydroxide when the colour changes to deep blue. There may be diarrhoea. Oliguria, hematuria, albuminuria and uremia may be seen. Jaundice is common. The person dies of shock.

Fatal Dose

15 gm of copper sulphate is sufficient to kill a person.

Fatal Period

1–3 days.

Treatment

Gastric lavage should be immediately done. It should be done with one per cent solution of potassium ferrocyanide to form insoluble cupric ferrocyanide which is harmless. Milk or egg white can be given as antidote. The albumin present would form insoluble harmless salt as albuminate of copper. Chelation therapy with BAL is recommended. In case of renal failure, dialysis should be done. The supportive treatment in form of fluids is essential. Ascorbic acid and methylene blue should be used for methaemoglobinaemia.

Post-mortem Appearance

The skin may be yellow due to jaundice. Greenish froth may be seen at mouth or nostrils. The mucosa of gastrointestinal tract is congested, swollen and may show ulcerations. The stomach contents are green or blue. The liver would be enlarged and may show necrosis.

Chronic Poisoning

The chronic poisoning is seen in workers in industries where copper dust or fumes are there.

Symptoms

Greenish or purple line on gums, a coppery taste in mouth, nausea, dyspepsia, vomiting, diarrhoea

with colic in abdomen may be seen. Renal damage may be seen. Peripheral neuritis, congestion and ulceration of cornea may be seen. Jaundice would be commonly seen. The hair, urine and sweat may be green coloured.

Treatment

The person should be removed from the site. The conservative treatment should be started.

Medico-legal Significance

Copper as a metal is non-poisonous. The copper sulphate is consumed with the purpose of committing suicide. Its strong metallic taste and blue colour makes it unfit for homicidal purpose. Accidental consumption can occur.

LEAD

The following preparations of lead are commonly used.

1. **Lead Acetate:** It is also known as 'sugar of lead or Salt of Saturn'. It is white mass of acicular crystals having sweet, astringent taste. When dissolved in water it forms acid solution. In old days, it was used to sweeten wine.
2. **Lead Subacetate:** It is the chief constituent of Goulard's extract which is a colourless liquid with a sweet, astringent taste and is alkaline in reaction.
3. **Lead Carbonate:** It is white, crystalline powder, insoluble in water but soluble in acids. It is extensively used as pigment in oil painting in basic carbonate form, commonly called *Safeda*. It is also used as an ointment.
4. **Lead Nitrate:** It is used in calico printing. It is a crystalline powder soluble in water.
5. **Lead Chromate:** It is bright yellow insoluble powder used as pigment. It is known as 'chrome yellow'. Some cases of poisoning have been reported when it is used to colour sweetmeats.
6. **Lead Sulphate:** This is heavy white powder insoluble in water. It is nonpoisonous.
7. **Lead Chloride:** It is white, needle-shaped crystal which is quite soluble in hot water but less in cold water. When it is heated with air, it is converted into oxychloride which is employed as white pigment, known as 'Pattison's white lead'. The yellow oxychloride is obtained by heating lead oxide and ammonium chloride. It is known as 'cassel yellow' and is used as pigment.
8. **Lead Iodide:** It is tasteless, odourless, yellow powder soluble more in hot water than cold.
9. **Lead Sulphide:** It is found in the form of cubic crystals. It is sold in markets as *surma* in place of sulphide of antimony which is used as collyrium for the eyes.
10. **Lead Monoxide:** It is pale brick red or orange scaly mass sometimes used by quacks for treating syphilis. It is also used by printers and glaziers and is also a constituent of some hair dyes.
11. **Lead Tetraoxide:** It is also known as *Sindoor*. It is scarlet, crystalline powder used as pigment. It is insoluble in water. It is used as vermilion but most often, vermilion is mercuric sulphide.
12. **Tetraethyl Lead:** It was added to prevent knocking in petrol. Now, it is not added and petrol available now is free from lead.

Acute Poisoning

Lead acetate is the most common salt that causes acute poisoning. The following symptoms are seen:

A sweet, metallic astringent taste in mouth along with burning sensation in throat and stomach, salivation and intense thirst are seen immediately after ingestion. Vomiting starts within 30 minutes. Colic in abdomen starts with tenderness in abdomen. Constipation is seen. Urine becomes scanty. The features of peripheral shock start appearing with cold clammy skin, feeble rapid pulse and shock. Drowsiness, headache, muscular cramps and

convulsions may be seen. Paralysis of lower limbs may be seen. Death may occur. In acute poisoning with tetraethyl lead, central nervous symptoms are the main features. Irritability, insomnia, headache, vertigo, muscular weakness, bradycardia, hypotension and convulsions may be seen.

Sub-acute form: The sub-acute poisoning occurs when small doses of lead acetate are taken repeatedly for a long time. Blue line is observed on the gums. Gastrointestinal symptoms as mentioned above are seen. The nervous symptoms are very prominent. Numbness, vertigo, cramps and paralysis of lower limbs may be seen. Death is rare but may occur due to convulsions and coma.

Fatal Dose

20 gm of lead acetate is fatal. About 45 gm of lead carbonate is fatal. A maximum daily intake of 5 µgm of lead per kg body weight is permissible.

Fatal Period

2–3 days is an average fatal period.

Treatment

Gastric lavage should be started immediately with one per cent magnesium or sodium sulphate solution. Emetics can be given to induce vomiting. Magnesium sulphate can be given orally to rapidly remove lead from the intestines. The intravenous fluid should be given. Morphine may be given to relieve pain. Chelation therapy should be started. Ethylene diamine tetra-acetic acid (EDTA) is preferred as it forms with lead non-toxic, non-ionised, non-metabolised compounds which are excreted in urine. The patient should be hospitalised and intravenous solution of calcium disodium versenate (calcium disodium ethylenediamine) should be started. Daily dose of 80 mg/kg for an adult may be given in divided doses for 5 days. It may be combined with intramuscular injection of BAL 15–30 mg/kg/day for better prognosis. Urine outflow should be maintained by infusing saline. Intracranial pressure should be maintained by giving mannitol, steroids and hypothermia. The

nutritional supplements like vitamin D, vitamin C and diet rich in calcium with milk should be given.

Post-mortem Appearance

The signs of irritation in stomach and intestines may be seen. The mucosa may be thickened and softened with white deposit. Erosion patches may be seen. The organs would be congested.

Chronic Poisoning (Plumbism or Saturnism)

The chronic poisoning is very common among workers in factories where lead and its products are widely used. The chronic poisoning occurs in paint sprayers, compositors, plumbers, enamel workers, glass blowers, electric light workers, lead ore refiners, etc. It may also result from taking food contaminated due to storage in vessels containing lead. It may also be due to drinking ground water containing lead, use of hair dyes and cosmetics. Chronic lead poisoning can also occur due to absorption from skin too. The women who are using red lead as vermilion may get poisoning in due course of time.

Clinical Features

The following are the main clinical features:

1. **Gastrointestinal Symptoms:** Severe colic relieved by pressure, constipation, anorexia and metallic taste are common. Intermittant vomiting may be seen.
2. **Lead line or Burtonian Line:** A stippled blue line is seen on the junction of the gums and teeth usually on upper jaw. It is due to deposition of lead sulphide, formed as a reaction of lead and hydrogen sulphide, which in turn, is formed as a result of decomposition of food in a bad oral hygiene person. Metallic taste in mouth and bad odour is observed.
3. **Anaemia:** Marked punctate basophilia, hypochromia and reticulocytosis is seen. Due to lead there is impairment in the synthesis of heme from protoporphyrin and

of porphobilinogen from aminolaevulinic acid. There is increased fragility of RBCs due to loss of intracellular potassium, which in turn, is due to increased permeability of the cell membrane. The basophilic stippling of the RBCs is due to condensation of iron containing ribonucleic acid near the mitochondria. These are stained with basic dyes and hence the name is given. Platelets are decreased. The children are more susceptible to develop anaemia.

4. **Paralysis:** Typical paralysis involves the extensor muscles of finger and wrist except the supinator longus, causes 'wrist drop' and 'claw-shaped hand'. When it is spread to extensor muscles of foot, it causes 'foot drop'. Axonal degeneration causes peripheral motor neuropathy. There is no sensory involvement. Extra ocular muscles are also affected. Tremors and pain in large joints are seen.
5. **Encephalopathy:** It develops when blood lead levels are more than 100 mg/dl and is usually seen in children. It can develop even after some time has passed off lead ingestion as lead releases into the system from the stored sites. Vomiting, irritability, clumsiness and loss of recently acquired development skills is seen. Abnormal jerky movements and ataxia may be there. Later, stupor, coma, convulsions and death may follow. CSF examination would show high protein and mononuclear cell counts. Permanent neurological deficits like poor performance in studies, mental retardation, optic neuropathy, hyperkinesias and cerebral palsy may be seen.
6. **Facial Pallor:** Circumoral facial pallor is characteristic. It may be due to vasospasm although anaemia is also responsible for it.
7. **CVS and Renal Manifestations:** High blood pressure and arteriosclerotic changes are seen. Urine contains albumin and high amount of lead, coproporphyrin-III and

deamino-laevulinic acid. Interstitial nephritis may be seen. Menstrual problems like menorrhagia, metrorrhagia, and abortions are seen. Still birth may be seen. Sterility may be there in men and women.

Diagnosis

For diagnosis of chronic lead poisoning, the quantitative estimation of lead in urine and blood should be done. The urine lead values are more than 0.08 mg/litre of blood when measured on 24 hour urine collection. The blood values are above 0.8 mg/litre of blood. Glycosuria is seen in children. For screening of lead toxicity, blood estimations of coproporphyrin and delta amino-laevulinic acid are done. A blood lead level of more than 30 mg/dl is indicative of undue lead absorption. Erythrocyte protoporphyrin levels less than 50 mg/dl are normal. EP levels are elevated in chronic lead poisoning but may be normal in acute lead poisoning. Elevation of EP levels are also seen in iron deficiency, chronic infections and haemolytic anaemias. In chronic poisoning, an abdominal X-ray can demonstrate flecks of lead paint. An X-ray of long bones may show 'lead lines' which are bands of increased density, and can be seen within days of ingestion. Calcium EDTA mobilisation test can be done. In this, EDTA is administered intramuscularly in two doses in a day. The urine is collected for 24 hours and lead concentration measured. If lead (μg)/Ca EDTA (mg) ratio is greater than one, it reflects five-fold increase in body lead burden and indicates poisoning.

Treatment

The person should be removed from the influence of the poison. The convulsions should be treated with anticonvulsants. Intracranial pressure should be controlled by giving mannitol and steroids. The urine outflow should be encouraged by giving fluids. If lead levels are 50–70 mg/dl and the patient is asymptomatic, the chelation therapy should be started with calcium EDTA 1000 mg/sq m/24 hours in divided doses intramuscularly at least for 5 days.

A second course can be given after a gap of 2 days. After the second course, penicillamine in a dose of 600 mg/sq.m/day can be given till blood lead level and EP levels are normal. If blood lead levels are more than 70 mg/ dl, chelation therapy should be a combination of calcium EDTA and BAL immediately. Combined therapy produces better excretion of lead.

If encephalopathy is present, BAL and calcium EDTA are administered for 5–7 days. The dose of calcium EDTA is 1500 mg/sq m/day and that of BAL is 450 mg/sq m/day.

Remove the retained lead pellets or bullets as much as you can, if they are producing the lead toxicity.

Post-mortem Appearance

A blue line along the margins of gums can be seen. The paralysis may be evident in form of flaccid, atrophy of muscles. Renal tubular necrosis may be seen. The liver and kidneys may be found to be hard and contracted. The rest of the findings are non-specific.

Medico-legal Significance

The medico-legal significance of lead poisoning is as follows:

1. Lead in the metallic form is not poisonous unless it is acted upon by intestinal secretions. When ingested, it can act as a poison as the metal is converted into salt and is absorbed. Such kind of poisoning can occur in workers working in soldering, plumbing, alloys, toys, ceramic, paint, and foil paper industries.
2. Retained lead bullets and pellets when embedded in tissues may produce poisoning over the years.
3. Acute lead poisoning is rare and usually the person recovers from it. Chronic lead poisoning is very common.
4. Lead is also sometimes used as an abortifacient criminally. Abortion sticks contain red lead as the main ingredient.

5. Red lead may also be used as a cattle poison.
6. Accidental poisonings are common with salts of lead.

ISOPROPANOL

It is also called ‘Blue Heaven or Isopropyl Alcohol’. It is colourless, volatile fluid with a faint smell of acetone. It has a bitter taste. It is commonly used in massage as rubbing alcohol. It is also used as disinfectant, paint remover, used in aftershave lotions, hair tonics, used as industrial solvent, etc.

Clinical Symptoms

Isopropanol is a very strong CNS depressant. The common clinical features are lethargy, vertigo, headache, confusion, ataxia, miosis, gastritis, abdominal pain, etc. Later, hypotension and apnoea may be seen. Myopathy, haemolytic anaemia and renal failure are also reported. Smell of acetone can be appreciated in breath.

Once the isopropanol is ingested, it is converted to acetone by alcohol dehydrogenase enzyme. Acetone is excreted in urine and breath. Laboratory findings show ketonuria and metabolic acidosis.

Fatal Dose

250–350 ml.

Treatment

Immediately, gastric lavage should be done and activated charcoal may be left after lavage. Rest of the treatment is supportive. Metabolic acidosis should be corrected. Skin decontamination is required if isopropanol is applied on the skin.

ETHYLENE GLYCOL

It is a colourless, odourless, non-volatile fluid and has a bitter sweet taste. It is used as an antifreeze, coolant in automobiles and hydraulic brake fluid in machinery.

Mechanism of Action

Once absorbed through gut on ingestion, it is converted to glycoaldehyde, glycolic acid and oxalic acid which inhibits oxidative phosphorylation. Metabolic pathways are affected.

Clinical Features

There are three stages described according to the time of ingestion. There are:

1. **Up to 12 Hours:** The common symptoms are vomiting, lethargy, nystagmus, ataxia, convulsions and coma.
2. **Up to 24 Hours:** It is due to effect on cardiovascular system. Tachycardia, tachypnoea, congestive heart failure, and shock may be seen.
3. **From 24 to 72 Hours:** It is due to effect on renal system. Oliguria, acute tubular necrosis and renal failure are seen. The laboratory findings are acidosis, calcium oxalate crystals in urine and hypocalcaemia may be seen. If examined under Wood's lamp, the urine will fluoresce if the antifreeze has been taken.

Fatal Dose

70–100 ml.

Treatment

Gastric lavage should be done immediately and activated charcoal may be left after lavage. Ethyl alcohol is the antidote and is given in the same manner as mentioned in methyl alcohol poisoning. It inhibits the metabolism of ethylene glycol by competitive inhibition as competing for the same enzyme, alcohol dehydrogenase. 4-methyl pyrazole can also be used. Calcium gluconate can be given to correct hypocalcaemia. Rest of the treatment is on supportive lines. Hemodialysis can be done.

IRON

Iron poisoning occurs in children due to accidental ingestion of higher doses of iron preparations used in clinical practice. The common preparations which are used clinically, are ferrous fumarate (cap. Autrin), ferrous sulphate (cap. Fefol), ferrous choline (cap. Ferrochelate) and ferric ammonium citrate (liquid phosphomin).

The poisoning mostly occurs due to consumption of high doses of these preparations.

Symptoms

There are four stages of iron poisoning which are as follows:

Stage I: It occurs within 6 hours of ingestion. The initial symptoms are nausea, vomiting, diarrhoea and gastrointestinal haemorrhage. Perforation and intestinal necrosis may be seen. Shock may be seen. CNS effects include lethargy and coma.

Stage II: It occurs between 6 and 24 hours, patient appears to be stable. Recovery may take place.

Stage III: This stage is seen only in some percentage of cases and show signs of systemic toxicity. It occurs in between 12 and 24 hours. The chief symptoms are severe metabolic acidosis, fever, coma, bleeding disorders, hepatic failure, renal failure and shock.

Stage IV: Intestinal obstruction and scarring may be seen after some weeks.

Fatal Dose

200–300 mg/kg is the fatal dose while mild to moderate intoxication occurs at 20–60 mg/kg and severe intoxication at 60 mg/kg.

Fatal Period

24–30 hours.

Treatment

Case of iron-poisoning can be treated in following ways:

1. Manage the patient conservatively. Secure airways and maintain breathing and circulation.
2. Gastric lavage may be done in a conscious patient with sodium bicarbonate solution and about 100 ml should be left behind after lavage.
3. Chelation therapy with de-feroxamine should be done. De-feroxamine in a dose of 90 mg/kg should be given intramuscularly followed by 90 mg/kg every 4–12 hours. Exchange transfusion is helpful in infants.

Post-mortem Features

The gastrointestinal tract would be inflamed and congested. It may show perforation and necrosis. The liver may show acute hepatic necrosis.

Medico-legal Significance

The iron poisoning is mainly accidental from over-dosage. The poisoning is commonly seen in children. Suicidal poisoning is sometimes reported. Homicidal poisoning is very rare.

THALLIUM

Thallium is a white crystalline metal and is extremely toxic. It is odourless and tasteless. These qualities make it one of the ideal homicidal poison. Thallium is used in manufacture of optical lens and in scintillation counters. There are two main thallium salts which are in common use.

1. **Thallium Acetate:** It is sometimes used in the treatment of ring worm of the scalp. It is colourless and odourless.
2. **Thallium Sulphate:** It is a potent rodenticide and is used for killing rats and ants.

Symptoms

Nausea, vomiting and severe haemorrhagic gastroenteritis are the main features and may

resemble natural gastroenteritis. Joint pain and skeletal muscle pain may be seen. Bone marrow depression may be seen. Hepatic and renal failure may be seen. Sensorimotor neuropathy, retrobulbar neuritis, disturbed colour vision, paraesthesias and occasional ophthalmoplegia are the other features seen. Myocardial toxicity may be evident in the form of hypertension, tachycardia and arrhythmias. Delirium, convulsions and coma may be seen. In most cases, respiratory failure and shock are the causes of death.

Late complications include alopecia, ataxia, choreiform movements, depression, dementia and psychosis. Mental retardation has also been reported. Rarely, SLE-like features, keratoconjunctivitis sicca and Raynaud's phenomenon have been reported.

Fatal Dose

12 mg per kg body weight is the minimum lethal dose.

Fatal Period

24–30 hours.

Mechanism of Action

Thallium is highly poisonous and it resembles lead in mechanism of action. It acts as an irritant to stomach and causes fatty changes in heart and liver. It also causes necrosis in kidney.

Treatment

Perform gastric lavage with Prussian blue (potassium ferric ferrocyanide) as it binds thallium in the gut and prevents its absorption. It is usually given via duodenal tube along with mannitol. It is given in a dose of 125 mg/kg body weight twice daily. Forced diuresis is helpful. Activated charcoal and saline purgatives can be given to enhance fecal excretion. The rest of the treatment is supportive. Hemodialysis is not effective.

Post-mortem Appearance

The mucosa lining of stomach is grossly congested and haemorrhages may be seen. The liver may show fatty changes. The necrosis in kidneys may be seen. The heart shows fatty degeneration. The rest of the organs are congested.

Medico-legal Points

Owing to its tasteless, odourless nature and the clinical features it produces, thallium is quite

close to being called an ideal homicidal poison. Suicidal and homicidal cases are reported. On X-ray examination, opacity in liver may be seen. Death due to gastrointestinal and polyneuritis with alopecia should raise suspicion regarding thallium poisoning, although, poisoning by thallium is rare. Chronic poisoning is seen among workers employed in chemical factories where thallium is isolated from pyrites residues.

Irritant Poisons—Animal Poisons

CANTHARIDES

The Spanish fly or blister beetle is a green coloured insect which is widely present. When the insect is dried up and turned into a powder, a brown coloured powder with green particles is obtained. The active principle is cantharidin. This principle is freely soluble in alcohol but not in water. It is a very strong vesicant. The Spanish fly is known as *cantharis vesicatoria*. In India, *teleni makhi* (*Mylabrisichorii*) is widely prevalent in north India and Kashmir. It also contains cantharidin. Other species of *teleni makhi* are also present throughout India.

Symptoms

On local application, cantharidin initially does not cause any side effects but after 2–3 hours, local redness and inflammation is seen which is followed by multiple blisters formation. Later, all blisters may combine and form a large area of necrosis. When ingested, within 2 hours it produces severe burning in mouth, throat and stomach. It causes blistering of tongue, swollen tongue, intense thirst, increased salivation due to inflammation of salivary glands, nausea, vomiting and diarrhoea. There is a pain in loins, increased frequency of urine, painful priapism with swelling and inflammation of genital organs. The patient becomes very restless. The person may die of peripheral shock with slow, feeble pulse along with low blood pressure. The voice of the person may become hoarse due to the vocal cord spasm.

Fatal Dose

About 1–2 gm.

Fatal Period

24–36 hours.

Treatment

Gastric lavage should be done immediately. Fluids should be started intravenously to avoid dehydration. The patient should be managed by supportive treatment.

Post-mortem Appearance

The green shining particles of powdered insects may be found in the stomach and intestine. The stomach and intestine may be found to be congested and ulcerated. Acute tubular necrosis may be seen. Lungs are congested and oedematous. Kidneys are congested.

Medico-legal Significance

The cantharides are used as aphrodisiac due to their tendency to cause priapism. They can also be used to produce criminal abortion. It is rarely used for suicidal and homicidal purposes. Accidental poisoning can occur due to application of blistering paper (*Charta epispastica*).

SNAKES (OPHIDIA)

Every year in India around 2 lakh people are bitten by snakes out of which around 15,000 die every year. Snakes are poisonous as well as non-poisonous. Majority of the snakes are non-poisonous. Majority of people die because of fear of death rather than snake bite. So, it is very important to reassure the person who has been bitten by a snake that it is likely that the snake may be a non-poisonous one. If the snake is caught dead or alive, it may be ascertained by examination whether it is poisonous or not.

Poisonous Snakes

The poisonous snakes belong to two families: Colubridae and Viperidae. The Colubridae snakes lay eggs. Their head is about the same width as the neck. The pupils are circular. There are two varieties:

1. Elapidae or land or terrestrial snakes.
2. Hydrophidae or sea snakes.

Elapidae (Terrestrial Snakes)

The common Elapidae snakes are cobra, king cobra, common krait, banded krait and the vipers (Fig. 33.1 and 33.2).

1. **Cobra:** It is also called *Nag* or *Kala Samp* due to its black colour. It occurs throughout India. It has a well marked hood. The hood may bear on dorsal side a double or single spectacle mark. The head of this snake is not very distinct from its neck. Its neck region dilates to form hood. It expands its hood only when it is enraged or about to attack. In a dead snake, hood cannot be appreciated as neck and joints become stiff. The average length is 5–6 feet. To identify a cobra following points are noted:

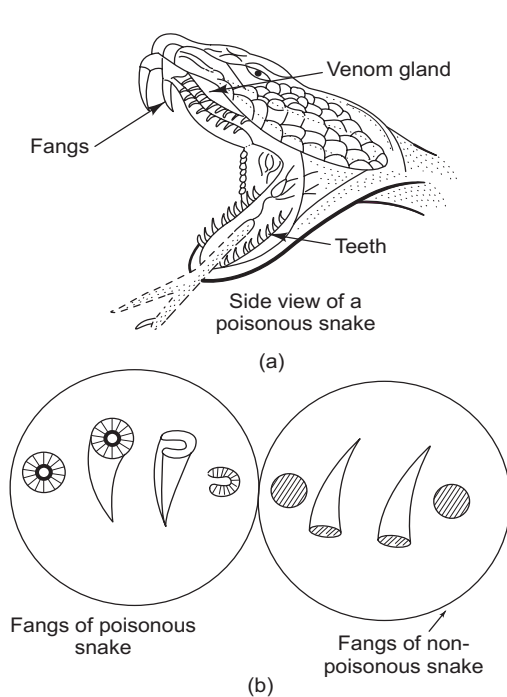


Fig. 33.1 (a) Side view of poisonous snakes, (b) fangs of poisonous and non-poisonous snakes.

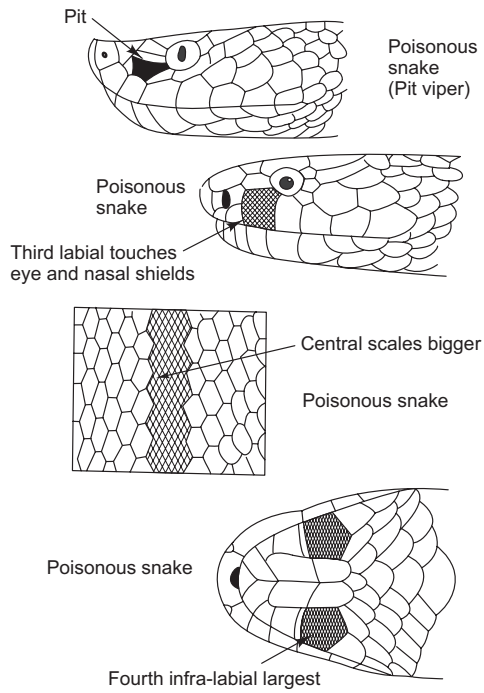


Fig. 33.2 Points to be noted in poisonous snakes (for details see text).

- (a) A small triangular shield commonly called cuneate or wedge shield is seen between the fourth and fifth infralabial shields.
- (b) Two black spots and three black bands may be seen on the central side of hood.
- (c) The caudal scales are double.
2. **King Cobra:** It is also called *Nag Raj* or *Raj Samp*. It is seen in the Himalayas, Bengal, Assam and in hills of south India. It is bigger than common cobra and may be 8–12 feet. The hood is less wide but longer than common cobra. On the head there are four chevron-shaped bars.
3. **Common Krait:** It is found all over India. The common length is 3–5 feet. It is usually steel blue in colour and has narrow single or double white arches across the back. These arches begin a bit far from the head and extend up to the tip of the tail. The belly is creamy white in colour. The common krait can be identified by the following features:
- (a) The head is covered with large shields.
- (b) Four shields are present on lower lip both sides.
- (c) The scales in the central row are large and hexagonal till the tail.
- (d) Round tail is seen.
- (e) The plates under the tail are like that present on the belly. They are in toto and not divided.
4. **Banded Krait:** It is larger than common krait. It is seen in northeast India. It has alternate jet black and deep yellow bands across the back.
5. **Black Krait:** It is blue or black in colour and devoid of stripes. The ventral side is white with black dots. The poison of the above snakes is neurotoxic (Table 33.1).
6. **Viperidae:** These snakes have broad, lozenge-shaped head covered with small scales, a narrow neck and a short tail. The pupils are vertically slit. They give birth to small snakes. They have mobile fangs.
- Vipers are of two types, *pit viper* and *pitless viper*. Pit vipers are those which have a pit or a deep depression on each side of the head between the eye and the nostrils. Pitless vipers are those which do not have pit on the head. They have broad plates on the belly.
- (a) **Russell's viper:** It is a pitless viper, usually called Daboia or Chain viper commonly found all over India except in the Ganges base. Normal length is 4–5 feet. It is very stout. The head is flat, heavy and triangular, and has a white v-shaped mark with its apex pointing forward. There are three rows of black or brown spots along the back. The body is white with dark semilunar spots. It produces hissing sound loudly and continuously when it is ready to attack. This snake can be identified by entire broad plates on belly, small scales on the head and the shield below the tail divided into two rows (Fig. 33.3).
- (b) **Saw-scaled viper:** It is a small snake which has a triangular head bearing a typical arrow-like mark on a brown background. The body is brown with a series of pale marks forming curves. This snake is commonly found in Punjab, Rajasthan, Kashmir and Maharashtra. The back is covered with rough scales which produce a rustling sound when the snake moves. The ridge in the middle of each scale is dented like a saw thus giving it the name of 'saw-scaled viper'. The snake is identified by broad belly plates, small scales on the head and entire shields below the tail. The poisonous snakes have two fangs which are connected to racemose glands which secrete venom through ducts. The venom is used for digestion. The glands similar to parotid glands. The colubrines have short and fine fangs which cannot penetrate through clothes while vipers have long and strong fangs which can penetrate through clothes (Fig. 33.4).

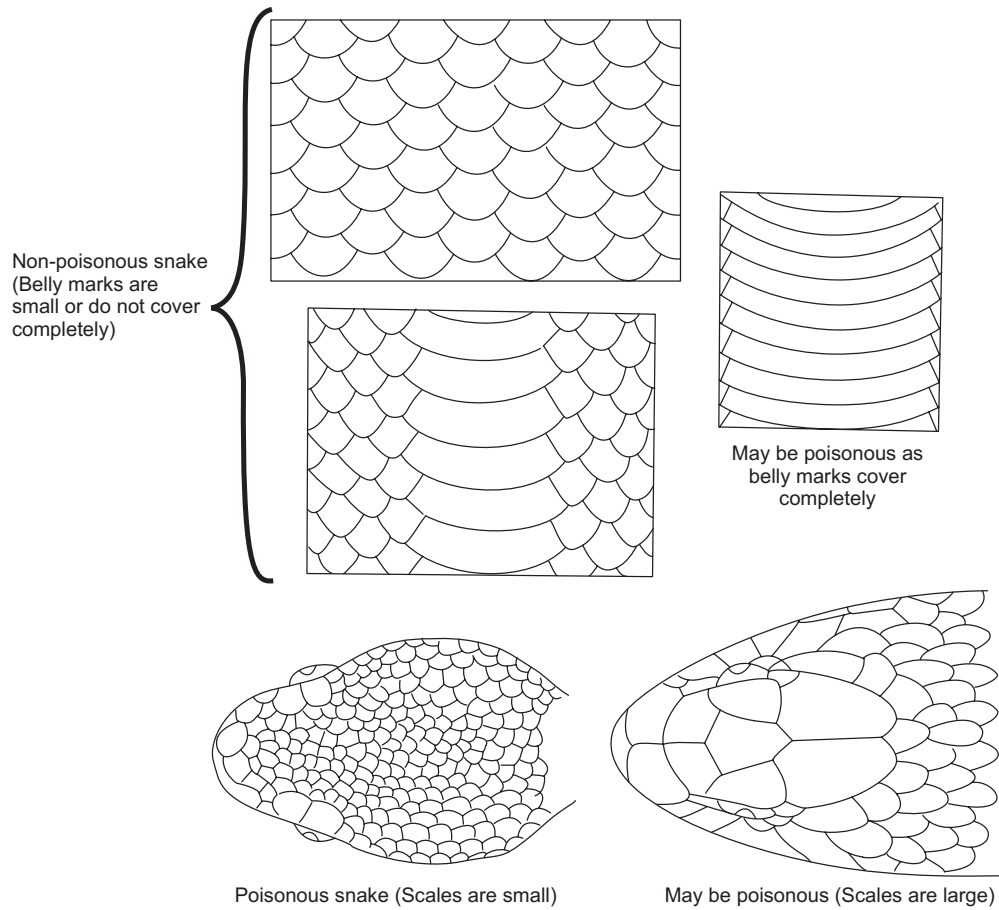


Fig. 33.3 Belly and head scales.

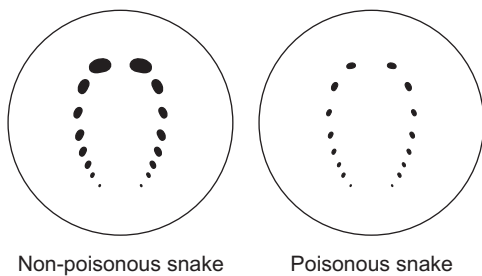


Fig. 33.4 Teeth bite marks.

sea snakes are not offensive and they rarely bite humans. The venom is neurotoxic and myotoxic. As a result, there is severe weakness due to muscle damage in bites due to sea snakes.

Snake Venom

Snake venom is highly concentrated, clear amber coloured digestive juice of the snake. When it is dried, it becomes like fine needles which are soluble in water. It has got proteolytic enzymes, phosphatidases, and neurotoxins. Proteolytic enzymes cause tissue destruction by liberating histamines by damaging muscular epithelium of blood vessels leading to release of RBCs and serum

Hydrophidae (Sea Snakes)

These are seen in coastal areas. The eyes are very small, and their tails are flattened like fins. They have short, immobile fangs. The body is round. Usually,

Table 33.1 Differences between poisonous and non-poisonous snake

Features	Poisonous snake	Non-poisonous snake
1. Body	Stout, dull coloured and abruptly tapering tail	Slender body, bright coloured, gradually tapering tail
2. Tail	Flattened or rounded	Always rounded
3. Belly scales	Broad	Small and do not extend across the entire width
4. Head	Mostly triangular in shape	Mostly oval or rounded
5. Head scales	Mostly small	Mostly large
6. Fangs (Teeth)	Fangs are present. May be grooved or channelised	Fangs missing. All teeth are small in size
7. Saliva	Toxic	Non-toxic

in tissues. Phosphatidases cause haemolysis and toxic effects on heart and circulation. Neurotoxins produce curare-like effect on CNS leading to paralysis. The snake venom also contains other enzymes like proteases, erepsin, choline esterases, hyaluronidase, ribonucleases and ophio-oxidases.

Non-poisonous Snakes

Majority of the snakes in India are non-poisonous. Most of the snakes have their belly covered with transverse plates which do not extend completely across it. The difference between poisonous and non-poisonous snakes are given in Table 33.1.

Fatal Dose

The fatal dose for common snake venom is as follows: Cobra 12 mg, Russell's viper 15 mg, Krait 6 mg, *Echis carinatus* 8 mg.

Symptoms of Snake Venom Poisoning

The clinical features of snake venom poisoning depends on many factors like type of snake, age and health of the patient, and site of snake bite.

Local Reaction

They are present more in viper snake bite. There is local swelling due to leakage of fluid as a result of damage of capillary endothelium. Pain and discolouration develop at the site of the bite. Within fifteen minutes nausea, vomiting and signs of collapse supervene. There is a cold clammy skin,

hypersalivation, thready, feeble, rapid pulse with low blood pressure is seen. The necrosis develops at the site. It develops slowly over the week and is mainly ischaemic and present itself as a form of dry gangrene. In cases of bite from colubrine snake such as cobra or krait, the immediate local actions are burning or tingling pain, irritation, swelling and inflammation. But the local reaction is very less as compared to viper snake bite. Within 15 minutes, constitutional symptoms develop in the form of giddiness, lethargy, muscular weakness, drowsiness and a feeling of intoxication. Nausea and vomiting may also be there. Weakness of muscles increases and paralysis of limbs develop. It spreads on to involve trunk and rest of the body. Breathing becomes slow and laboured. The death occurs due to coma.

Snake venom whether it is from cobra or viper group of snakes, it has haemolytic action on blood. It reduces coagulability of blood leading to oozing of blood from the site of the bite. Spontaneous oozing of blood into vital organs such as brain can occur up to several days after the bite. It is due to direct endothelial damage caused by venom component.

Acute renal failure may follow within one week. It is due to combination of factors like shock, myolysis, direct effect of venom and intravascular haemolysis.

Myotoxic effects are the main features in sea snake bite. Generalised muscle pain is seen in all skeletal muscles of the body. Pituitary failure in

the form of pituitary haemorrhage may be seen in Russell's viper bites. Sweating, cold extremities, tachycardia, hypotension and ECG changes (S-T changes) are the features of cardiovascular depression seen in cobra and viper bites. Hyperkalaemia leading to cardiac arrest is seen in sea snake poisoning. Hyperkalaemia occurs as a result of muscle damage. As snake venom can cross placenta, when pregnant women is bitten by snake, her foetus can die too due to venom effect.

Specific Findings in Various Snake Bites

1. **Common Krait:** Venom is neurotoxic. Not much pain or swelling at local site but within 1 hour the victim feels sleepy and neurotoxicity develops.
2. **Cobra:** Swelling at local site develops not before 2–3 hours. Necrosis develops more rapidly and may be seen as wet gangrene in 2–3 days. Local symptoms include reddish tender spot with burning pain. The neurotoxic effects start within 30–60 minutes.
3. **Sea Snakes:** Venom is most toxic as compared to cobra and vipers. Snake bite is small pin-head puncture usually 1–8 in number, without much local pain. Paralysis and rhabdomyolysis are seen. Painful muscular movement, ascending paralysis, slurred speech, dysphagia, ptosis and myoglobulinuria are seen. Bulbar involvement may lead to respiratory failure.
4. **Russell's Viper and *Echis Carinatus*:** Severe local reaction is followed by swelling in 15–20 minutes. Local necrosis appears slowly over weeks and present as dry gangrene. The death is caused due to shock developing within one week.

Fatal Period

In case of colubrine snake, death may occur from 20 minutes to 6 hours while in case of viperidae it may take 2–4 days.

Treatment

It may be divided into two stages. First is, first aid that can be provided at the site only, secondly, hospital treatment is provided.

First Aid

1. Reassure the patient. It is very important, as many people just die because of neurogenic shock resulting from fear of death. Majority of the snakes are non-poisonous. It may be assured to the patient that it may be possible that he may have been bitten by a non-poisonous snake, if the snake is not traceable. Even in poisonous snake bite, reassure the patient that he may not die and everything is being done.
2. Wash the site of bite thoroughly with plain water or an antiseptic.
3. Incision and Suction: The application of incision and suction is controversial. Incision can increase bleeding, damage nerves and tendons, delay healing and may cause infections. Incision is helpful if it is done within 15 minutes of bite. A linear incision should be made which is only skin deep. The suction should be done preferably with a breast pump or mouth. The person who does suction by mouth should not have ulcers or sores in the mouth or lips. Suction can be done up to 1 hour of the bite.
4. If evacuation to a hospital will take more than 30 minutes, then a bandage or ligature should be applied above the site of the bite. It should not be very tight. It should allow two fingers under it. If swelling appears due to ligature, apply another one above the first before releasing the first one.
5. During transit, the patient should not be moved unnecessarily as it would spread the venom.
6. If snake has been caught or killed, it should also be carried to hospital to identify whether it is poisonous or not and belongs to which species.

Hospital Treatment

1. The patient should be admitted at once and his clinical status should be evaluated.
2. The ligature applied should be removed. The bite site should be cleaned but no dressing should be applied. The limb should be elevated.
3. Antivenin should be started immediately once the signs of poisoning are noted. Antivenin is prepared from horses. Usually, it is of two types—monovalent that is specific to one snake and polyvalent, which is for a group of common snakes. The Haffkine Institute prepares polyvalent anti-snake venom which is quite effective against cobra, common krait and Russell's viper. Slowly, 20 ml of polyvalent anti-snake venom serum should be injected intravenously as early as possible and the dose should be repeated after 2 hours. The dose may be repeated after every 6 hours till the symptoms of poisoning disappear. There is no need to do sensitivity test. If there is an allergic reaction, it should be managed with epinephrine.
4. The local necrosis should be managed with antibiotics, excision of slough and use of skin grafting.
5. Analgesics may be given for relief of pain. Blood transfusion is helpful in viper bites.
6. Use cholinergics to counter neurotoxic effects of elapid bites. Neostigmine can be given to minimise neurotoxic effects.
7. Pulse, blood pressure and respiration should be monitored.
8. Abnormal bleeding should be looked for.
9. Necessary investigations like haemoglobin, TLC, DLC, ESR, urine output, blood urea, creatinine, SGOT, SGPT, EPK and ECG should be done.

Post-mortem Appearance

Two lacerated punctures about 1.25 cm deep in case of colubrids and about 2.5 cm deep in vipers can

be seen as a rule. Sometimes, they may be so minute that they can be seen only by a lens. Swelling and cellulitis may be seen around the part which is bitten. Petechial haemorrhages and intense congestion is seen in different organs.

Medico-legal Significance

Most snake bites are accidental in nature. Cases have been reported when snakes have been used for homicide by putting the snakes near the victim. Suicide by snake bite is rare but reported.

POISONOUS INSECTS

Ants

Ants secrete formic acid from their glands situated in the tail and it causes pain, irritation and swelling when they bite. The wounds should be thoroughly cleaned and antiseptic solution may be applied. If needed, analgesics may be given.

Wasp, Bees and Hornets

The bee venom contains histamine and melittin, hyaluronidase, phospholipase, apamin and peptides. The wasp venom contains serotonin, histamine, kinin, hyaluronidase and phospholipases. Single bite may produce local irritation, burning and swelling but when a person is attacked by many wasps, the person may go into shock due to anaphylactic reaction. Generalised itching, urticaria, sense of constriction in the chest, tachycardia, cold clammy skin, hypotension and finally death may be seen. In treatment, the bite should be examined. Sting of the bee should be removed if present. Local anti-inflammatory ointment should be applied along with analgesics given orally or by intramuscular route. In severe bites, steroids should be given immediately. If needed, endotracheal intubation may be done. The anti-inflammatory drugs should be administered intravenously.

Scorpions

The scorpions have a hollow sting in the last joint of their tail which communicates with a poisonous gland through a duct. The poison contains neurotoxin, haemolysins, agglutinins, haemorrhagins, phospholipases, lecithins and cholesterolin. The neurotoxin causes depression of vasomotor centres.

When scorpion bites, it produces intense burning and swelling at the site. It may cause giddiness, faintness, muscular weakness, vomiting, diarrhoea, convulsions and sometimes death.

In treatment, apply a ligature above the bite and incise it. The wound should be cleaned with antiseptic solution. The steroids may be given

intravenously to manage shock. Anti-inflammatory and analgesic drugs should be used.

INSULIN POISONING

Many cases have been described where insulin has been used to kill the person. The insulin is injected as adjunct to some injection or mixed in the intravenous fluid if a person is already receiving it. The insulin causes hypoglycaemia when given in large doses. The symptoms include weakness, fatigue, hunger, dizziness, cramps, tachycardia, excessive sweating, delirium, shock, dilated pupils, hypotension, coma and death. Blood sugar level below 50 mg per 100 ml of blood may be found.

Irritant Poisons—Mechanical Poisons

Mechanical poisons do not come into the category of poisons as they do not produce toxic effect per se. They are not absorbed into the body but cause mechanical obstruction in gastrointestinal tract. They cause irritation, perforation and obstruction due to their edges or sharp points. But they are included into the list of poisons in the expression “Unwholesome drug or other drug” in Section 328 of the Indian Penal Code. Some common mechanical poisons are powdered glass, diamond powder, pins, needles, nail, chopped animal and vegetable hairs.

POWDERED GLASS

Symptoms

There is sharp and severe burning pain in throat and stomach when it is taken in through mouth. Nausea and vomiting may follow. The sharp ends of glass may cause severe erosion of the oesophagus, stomach and intestine leading to severe bleeding or perforation. Generally, constipation occurs but diarrhoea may also be seen with blood.

Fatal Dose

Uncertain. Even large doses are sometimes not fatal.

Fatal Period

Uncertain. Death may occur in hours to days.

Treatment

Give bulky food like bananas, rice or isabgol. After that, purgative may be given. Antacids may be given later to soothe gastric or oesophageal mucosa. If sharp ends are present, one may have to resort to surgery to remove pieces.

Post-mortem Appearance

Erosion is widely seen in mouth, pharynx, oesophagus, stomach and intestine. Fragments of glass are seen adhered to stomach wall. The mucosal membranes are congested and inflamed.

Medico-legal Significance

It is a general belief that glass is highly poisonous. So, it is given for homicidal purposes by mixing it in food like rice or vegetables. Powdered glass is rarely used for suicidal purposes. It may be used for killing cattle. Many artists show eating of glass in circuses and public shows.

DIAMOND POWDER

It is a common belief that diamond powder is very toxic but it is not. Diamond powder causes irritation in the gastrointestinal tract due to its sharp and prominent edges. The treatment includes giving bulky food and then laxatives. Later, antacids may

be given to soothe gastric and intestinal mucosa. A criminal may swallow diamonds to steal or escape from police search.

NEEDLES AND PINS

Needles and pins when consumed through oral route cause severe burning pain and irritation in the oesophagus and stomach. Due to very sharp edges it may cause perforation or may be impacted in mucosa wall. Death may occur due to perforation. Treatment includes giving bulky food and then laxatives. But sometimes, surgery may be required to remove needles and pins as they are impacted in the mucosa wall. X-ray examination is quite helpful in locating the exact site of impaction. Needles and pins may be accidentally ingested while working. Such incidents are common in children. Suicides and homicides are rare.

CHOPPED ANIMAL HAIRS

It is a general belief that chopped animal hairs are quite poisonous but it is not true. They cause irritation in the stomach and may cause vomiting

and diarrhoea. Sometimes, they are given to animals to kill them but rarely do they cause any harm. At times, if they are not excreted out through faeces, they may cause intestinal obstruction and digestive disorders. Sometimes, chopped animal hairs are given in the food to punish someone rather than kill him.

VEGETABLE HAIRS

These are fine, short hairs derived from leaves and stalks of certain plants and called stinging hairs. They cause mechanical irritation when they come into contact with skin or mucosa. Sometimes, these hairs have short bulbs attached to them which contain irritant fluid consisting of histamine and acetyl choline. The fluids also cause irritation when they come in contact with skin. Treatment includes washing the area where the juice has come in contact with, with water and later anti-septic and antiinflammatory lotion may be applied. If these vegetable hairs are ingested, bulky food may be given followed by laxatives. Cases have been reported where these hair have been applied to fellow-passengers in train to produce irritation with a view to divert attention to rob the person.

Neurotic Poisons—Somniferous Poisons

The neurotic poisons can be sub-divided into following categories depending upon their action:

1. Somniferous poisons
2. Inebriant poisons
3. Deliriant poisons.

Somniferous poisons are those which act on the brain producing narcotic analgesia. The most important somniferous poison is opium and its derivatives.

OPIUM

It is commonly called *afim*. Opium is coagulated air dried, latex juice obtained by incision of unripe capsules of white poppy, known as *Papaver somniferum*. The family name is Papaveraceae and is widely grown all over the world. In India, it grows widely and also cultivated under government licence. The whole production of poppy is taken by the government and is processed by the government. Opium factory at Ghazipur, Uttar Pradesh, is utilized to obtain morphine.

Poppy capsules (*Post ka doda*) when they are ripe and dry contain traces of opium. They are used for sedative and narcotic effect. The warm decoction obtained from them is used as sedative fermentation and poultice (Fig. 35.1). Poppy seeds (*Khas khas*) are white in colour and do not contain morphine or any sedative and are

used as food. They are sprinkled over sweets. They are considered as demulcent and nutritive. Poppy seed oil commonly known as *Khas khas ka tel* is obtained from them and is used for culinary and lighting purposes. Opium is irregularly formed, has strong characteristic smell and bitter taste. Opium contains about 25 alkaloids combined with meconic, lactic and sulphuric acid. There are two groups of alkaloids present in opium.

1. **Phenanthrene Group:** Morphine, codeine, thebaine and their derivatives.
2. **Benzyl Isoquinoline Group:** Papaverine and narcotine.

The most important alkaloid is morphine followed by codeine, narcotine, papaverine and thebaine.

MORPHINE

The chemical formula is $C_{17}H_{19}O_3N$. The morphine is named after a Greek god, Morpheus, who is considered as God of dreams. It occurs as white powder or white shining crystals with bitter taste and alkaline reaction. Morphine has depressive effect on cerebral cortex, respiratory system and depresses cough reflex. The vomiting centres and vagus are stimulated. Morphine causes stimulation of spinal cord. Morphine causes analgesia due to depression of pain perception and its euphoric effects.



Fig. 35.1 Poppy plant with its capsule.

Heroin

It is a synthetic derivative of morphine. It is diacetyl morphine or diamorphine hydrochloridum. It is more analgesic and euphorigenic than morphine. It can be smoked or injected. It is marketed by drug peddlers as *white sugar*. It is one of the most addictive alkaloids on earth and is banned all over the world. A slight variant called *brown sugar* is also available in the market. It contains impure variant of heroin and may sometimes contain other narcotics like ganja, charas, etc. The brown sugar is widely used in poor countries and in India as it is quite cheap as compared to pure heroin (white sugar). Heroin can also be taken as snuff.

Heroin is an oxidation product of morphine and is colourless, crystalline in nature and soluble in alcohol and water.

Codeine

The chemical formula of codeine is $C_{18}H_{21}O_3H$ (methyl morphine). It occurs as colourless, crystalline form and is soluble in water. Codeine is commonly used in clinical practice for suppression of cough. Other alkaloids like narcotine, papaverine and thebaine are not much important as their toxicity is reported to be very less. Papaverine is

not narcotic in nature but causes relaxation of smooth muscles. Thebaine can cause convulsions. Narcotine is very less poisonous and can produce effect only in large doses.

Acute Poisoning

The effects of acute poisoning starts within 30 minutes of consumption. The effects can be divided into three stages:

1. **Stage of Euphoria:** This is the first stage where chief symptoms are increased sense of well being, mental activity, hallucinations and freedom from anxiety. This stage lasts for a short duration.
2. **Stage of Sopor:** The chief symptoms are headache, nausea, vomiting, giddiness, drowsiness and desire to sleep. The pupils are constricted. The face and lip appear cyanosed. Itching sensation may be there.
3. **Stage of Narcosis:** The person now passes into a deeper stage of coma. There is muscular relaxation with lost reflexes. The person cannot be aroused from deep coma. The face is pale and the lips are livid. The pupils are constricted to pin points, are insensitive to light, and the vision is tubular. The blood pressure begins to fall and slowly respiration becomes slow and laboured. There may be cheyne-stokes breathing and finally death may occur due to respiratory failure causing asphyxia.

Unusual Symptoms

The following unusual symptoms can be seen in acute poisoning:

1. Vomiting and purging.
2. Convulsions like in tetanus in codeine poisoning.
3. Syncope.
4. Hypothermia may occur in some persons and is caused by muscular hypotonia and

peripheral vasodilatation. In such a situation, the pupil would be dilated.

5. Tachycardia, cardiac conduction defects and cardiac arrest may be seen.
6. Non-cardiogenic pulmonary oedema can be seen in poisoning due to heroin, codeine and methadone.
7. Pressure necrosis of muscles can be seen in a prolonged deep coma but opium induced rhabdomyolysis, not due to pressure, can also be seen. Elevated CPK, hypocalcaemia and hyperphosphataemia would be seen.

Differential Diagnosis of Opium Poisoning

In all cases of suspected opium poisoning, the following conditions must be suspected and ruled out:

1. **Apoplexy:** Usually seen in elderly person. History of uncontrolled blood pressure or long standing history of hypertension may be there. Hemiplegia may be seen. The pupils are dilated and blood pressure may be high.
2. **Uraemic Coma:** Long standing history of kidney disease with abnormal renal function tests may be seen. Urine may show albumin.
3. **Diabetic Coma:** History of diabetes mellitus may be there. Intraocular tension is low. The pupils would be dilated. High blood sugar can be demonstrated.
4. **Epileptic Coma:** History of epileptic fit may be there. The pupils are dilated. Coma is less as compared to opium poisoning.
5. **Hysterical Coma:** Usually seen in females especially young. Some sort of mental problem may be there in the family. Respond well to ammonia. Tongue is not bitten. Convulsive movements may be seen. Pupils are normal.
6. **Acute Alcohol Poisoning:** Smell of alcohol present in breath and pupils are dilated.
7. **Carbolic Acid Poisoning:** Characteristic odour in breath, white patches on mouth,

green coloured urine and normal pupils are the main features.

8. **Barbiturate Poisoning:** Pupils are dilated with high respiratory rate.
9. **Head Injury:** The presence of injuries on head like abrasion, contusion, laceration or fracture of skull bones may be seen. Bleeding from nose or ears may be seen.

Fatal Dose

Approximately 1–2 gm is fatal in young adults. Children require about 0.5–1 gm as fatal dose.

Fatal Period

The average fatal period is 8–12 hours.

Treatment

Opium poisoning can be treated in following ways:

1. **Gastric Lavage:** It should immediately be done first with warm water. Sample of gastric lavage must be preserved. Later, the stomach wash can be done with a solution of potassium permanganate which converts opium and its alkaloids into harmless compound by oxidation. It converts morphine into oxydimorphine. Even in cases where morphine is given by any route other than oral, gastric lavage should be done as morphine is re-excreted into stomach.
2. **Airways:** They should be secured. If needed, endotracheal intubation should be done. Oxygen should be started.
3. **Antidote:** Once it is confirmed that the person has taken opiates, naloxone in dose of 0.4–1.2 mg should be given intravenously at once. The person should be observed for next three minutes. If there is a change in size of pupils, respiratory rate and level of consciousness, it is a positive sign. If a positive response does not occur, 1.2–2.0 mg of naloxone should be given every 3–5

minutes till a response occurs or the dose reaches about 4–10 mg. The naloxone has a half-life of 1 hour, so it has to be given continuously. If required, intravenous infusion can be given.

Pethidine hydrochloride and methadone are morphine-like compounds and require same treatment.

4. **Body Heat:** The body heat should be maintained by warm blankets. Hypotension should be treated with fluids. The patient should be monitored for late deterioration.

Post-mortem Findings

The post-mortem findings are not very specific but signs of asphyxial death are present. The smell of opium can be appreciated when body cavities are opened. The organs are congested.

Medico-legal Significance

Opium is one of the commonest drugs of abuse. A large number of people are addicted to opium in different ways. The most common is heroin which is widely used all over the world and is taken either by injection or snuffed by putting it on cigarette foil and heating it from below. In villages, many people consume opium. Opium is also widely used for committing suicide. Many medical and para medical professionals have committed suicide by injecting morphine along with skeletal muscle relaxants. Opium is also used as a cattle poison. Small children are sometimes killed by drugging them with opium. Since opium is eliminated in urine and faeces, samples of urine and faeces can be preserved in cases where stomachwash has not given positive tests.

CHAPTER 36

Cerebral Poisons—Inebriant Poisons

ALCOHOL (ETHYL ALCOHOL)

The chemical formula is C_2H_5OH . It is one of the most common inebriant poisons used all over the world, mostly as a social drink. It is colourless, transparent, volatile liquid, having a characteristic smell and a burning taste. It is very commonly used as a solvent for fats, resins, volatile oils, etc. It is also commonly used as base in liquid medicines. In cough syrups, it is found in very high concentration. Some ayurvedic medicines contain very high concentration of alcohol and are commonly abused.

In alcoholic drinks, the percentage of alcohol is very high. Table 36.1 shows concentration of alcohol in common alcoholic beverages.

Absolute alcohol contains about 99.95 per cent alcohol. Rectified spirit contains about 90 per cent

while industrial methylated spirit or denatured alcohol contains 95 per cent alcohol and 5 per cent wood naphtha. Rectified spirit used in clinical practice contains minor quantity of copper sulphate, which is added to make it unfit for ingestion.

Acute Poisoning

It results from consumption of alcoholic beverages in large doses or small doses over a period of time. The following clinical features are noticed:

Clinical Symptoms

Stage I: The first symptoms are sense of well-being, self-confidence and exhilaration. Alcohol in small doses cause inhibition of social inhibitions. The person becomes talkative. The face becomes flushed. He may become argumentative, show carefree behaviour, become sentimental or sad or depressed. Gradual loss of self-control is seen. These symptoms are seen when concentration of alcohol in blood is about 80–100 mg per 100 ml of blood. The breath smells of alcohol.

Stage II: If alcohol concentration rises further, there is a stage of confusion, perception becomes dull and there is muscular incoordination. The gait becomes staggering. The voice becomes slurred and speech is incoherent. The vision becomes blurred and stupor follows. There may be

Table 36.1 Concentration of alcohol in common alcoholic beverages

Brand	Percentage of alcohol
1. Whisky	40
2. Rum	40–60
3. Gin	40
4. Brandy	40–50
5. Light lager beer	3–4
6. Strong beers	8–10
7. Wine	20
8. Champagne	10–30
9. Vodka	40–60

severe nausea and vomiting which may relieve the poisoning. These symptoms are seen in blood concentration 100–200 mg per 100 ml of blood. The breath smells of alcohol.

Stage III: If alcohol concentration goes beyond 180–200 mg, the person starts having severe sleep, severe headache and gradually passes into a stage of unconsciousness and finally into deep coma leading to death. There may be full rapid pulse with stertorous breathing. Pulse gradually becomes slow and finally stops. The pupils are dilated in the early stage but may be constricted in late stages or in coma. The breath smells of alcohol. Positional nystagmus is seen which changes its direction according to the change in the position of head. When the jerking movement is in the direction of gaze irrespective of the position of head, it is called ‘alcohol gaze nystagmus’. On stimulation of the subject by pinching on face or neck, pupils dilate initially and slowly return to their original size. This is known as *MacEwen’s Sign*. The body temperature falls. Death may be due to asphyxia as a result of respiratory failure as alcohol depresses vasomotor centres. Convulsion may precede death. Death may occur if blood alcohol level goes above 250–300 mg per 100 ml of blood. Alcohol levels above 300 mg per 100 ml of blood are fatal.

Fatal Dose

It depends on age, sex and health of the individual while chronic users can tolerate high doses. If alcohol is consumed faster, less dose is required. About 150–250 ml of absolute alcohol may be an average fatal dose for an adult. The consumption of full bottle (750 ml) of whisky can cause death.

Fatal Period

Usually it is 12–24 hours.

Treatment

If a patient is brought in early stages, gastric lavage is of much use. It should be done with sodium

bicarbonate. If the patient comes late, gastric lavage is not indicated as it removes only a small amount of alcohol from the alimentary canal. If the victim is unconscious, gastric lavage should be done only after protecting the airway by endotracheal tube. Treatment is mainly supportive as the patient will improve slowly. Alcohol poisoning should be differentiated from barbiturate poisoning, head injury, cardiovascular accidents and hypoglycaemia. CT scan of head should be done if needed. Intravenous fluids should not be given in large doses. Hemodialysis may be done in severe cases. Vitamin B should be given to all patients where glucose is administered. Recovery occurs in due course of time if complications do not set in.

Post-mortem Appearance

The findings are suggestive of asphyxial death. The rigor mortis may be delayed. Decomposition may be retarded in some cases. The alcoholic smell can be appreciated well when body cavities are opened. The mucosa of stomach and intestine may be found to be congested. The liver, lungs and brain are congested. The blood is dark and fluid. The viscera should be preserved in saturated solution of common salt.

Chronic Poisoning

Chronic alcohol poisoning is rampant all over the world. Alcohol is consumed by habitual drinkers for a very long time. Addiction to alcohol may be due to mental stress, unemployment, failure in love, loss of self-esteem, poverty, marital disharmony, etc. Chronic alcohol addiction is commonly seen in lower socioeconomic strata and it causes abnormal physical and mental behaviour. The addict may steal things to get money for drinking. He may become quarrelsome and hence beat wife and children. He may resort to criminal behaviour and may commit homicide or suicide.

The patient suffering from chronic addiction to alcohol suffers from loss of appetite, nausea, vomiting, especially in the morning, and diarrhoea.

Due to chronic damage to liver, jaundice may be seen. Tremors of tongue and hands may be seen. Loss of memory, insomnia, impaired power of judgement, confusion and abnormal mental behaviour are seen. Features of malnutrition and chronic vitamin deficiencies are seen. Chronic alcoholic myopathy and neuropathies are seen later in addiction. Dementia may be seen in later stages. The following common complications are observed:

1. **Alimentary Canal:** Gastritis, increased incidence of peptic ulcer and carcinoma.
2. **Liver:** Fatty liver, cirrhosis, portal hypertension and hepatitis.
3. **Pancreas:** Acute or chronic pancreatitis.
4. **Cardiovascular System:** Cardiomyopathy, hypertension and arrhythmias.
5. **Central Nervous System:** Polyneuropathy, cerebellar degeneration, demyelination of corpus callosum and amblyopia, stroke.
6. **Respiratory System:** Aspiration pneumonia.
7. **Endocrine System:** Hypogonadism and feminisation in males, impotence, menorrhagia and amenorrhoea.
8. **Blood:** Hypochromic anaemia and thrombocytopenia.
9. **Skeletal Muscle:** Myopathy.
10. **Neuropsychiatric Complications:** Loss of memory, delusions, delirium tremens, Wernicke's encephalopathy, Korsakoff's psychosis, dementia and hallucinations.

Once a person who is addicted to alcohol does not take alcohol for a period of time, he gets withdrawal reaction which is described as follows:

1. The person starts getting tremors, commonly called shakes of hands, legs and trunk, sweating, headache, insomnia and person becomes very agitated and demands alcohol. These are usually seen in 8–10 hours of cessation of alcohol.
2. The person starts having hallucinations and seizures commonly called 'rum tits'. Tonic-clonic convulsions may be seen. These develop within 40 hours.

3. Alcoholic ketoacidosis may be seen in 1–3 days. The person may have drowsiness, confusion, tachycardia and difficulty in breathing. Ketone bodies can be demonstrated in blood and urine. Hypokalaemia may be seen.
4. *Delirium Tremens:* It may be seen in 4–5 days. In this, there is loss of recent memory, clouding of consciousness and disorientation. Hallucinations are there. They may be visual or auditory in nature.

The person is highly agitated, restless and may shout a lot. Tremors are seen with truncal ataxia. Sweating, tachycardia, dilated pupils, dehydration and impaired liver functions may be seen. Disorientation of time and place is seen.

5. *Wernicke-Korsakoff syndrome:* It is very rare. It occurs due to thiamine deficiency which in turn results from improper diet taken by the addict due to chronic alcoholic addiction. In acute form, drowsiness, disorientation, ataxia, amnesia and peripheral neuropathy are seen. Horizontal nystagmus and external ocular palsies may be seen. If a person recovers from the acute stage he may land into the chronic form called Korsakoff psychosis characterised by impairment of memory and confabulation.

Treatment of Chronic Alcoholic Addiction

The most important aspect in the treatment is to educate and motivate the addict to leave alcohol. Psychological aspect has to be taken care of very well. The counsellor should spend time in dealing with emotional crisis of the addict. The medical treatment consists of:

1. **Treatment of Withdrawal Systems:** The withdrawal symptoms should be treated with carbamazepine which is quite effective even in delirium tremens. Chlormethiazole is also used for treatment of withdrawal symptoms. The drugs are given for a period

of 1–2 weeks and are withdrawn slowly by reducing doses. Some clinicians have reported good results with clonidine.

2. **Antabuse Therapy:** Once the patient is stabilised after taking care of withdrawal reaction, Antabuse therapy can be started. The purpose of Antabuse therapy is to detoxify the individual. The insatiable desire to drink alcohol can be treated with Antabuse. The common drug used is disulfiram (tetra-ethylthiuram disulphide). The Antabuse interferes with oxidative metabolism of ethanol at acetaldehyde level. As a result of which, if alcohol is consumed with Antabuse therapy on, there is accumulation of acetaldehyde which causes unpleasant symptoms. So, once the patient is on disulfiram therapy he avoids taking alcohol to avoid unpleasant symptoms like flushing, palpitation, throbbing headache, nausea and vomiting, sweating, chest pain, hypotension and vertigo. The usual dose of disulfiram is 250 mg/day for a long time.

There are other drugs also which produce Antabuse-like reaction with ethanol, but they are rarely used for detoxification. Such drugs include cephalosporins, chloramphenicol, metronidazole, furazolidine, griseo-fulvin, glipizide, chlorpropamide and MAO inhibitors. Some chemicals like calcium cyanamide, carbon disulphide, tetraethyl lead and hydrogen sulphide also produce Antabuse reaction. Some mushrooms and activated charcoal may also give Antabuse reaction with alcohol.

3. **Supportive Psychotherapy:** This is the corner stone of deaddiction, as the patient may pick up the habit of drinking alcohol again once he leaves the hospital. Support from family members, office colleagues and friends may be sought. The patient should be called to hospital for psychotherapy regularly. Alcoholics Anonymous is the most famous international organisation

working in this regard and the patient may be asked to join the local branch of this organisation. A well balanced diet with vitamins should be given.

Post-mortem Appearance

The gastric mucosa may show signs of gastritis. The liver is congested. Cirrhotic changes may be seen. Fatty changes in liver and heart are present. Cardiomyopathy may be seen. General features of malnutrition may be seen. The odour of alcohol can be appreciated in body cavities.

Pharmacokinetics of Alcohol

Once ingested, alcohol initially stimulates production of hydrochloric acid in the strength of 5–10 per cent. But if it is above 15 per cent, it causes gastritis. Once alcohol is taken, it is mostly absorbed through small intestine and only less than 20 per cent is absorbed through stomach. The absorption of alcohol in the body depends on many factors. If taken empty stomach, it is absorbed more easily. If fatty food is taken its absorption is delayed. Milk delays absorption of alcohol. In 30 minutes to 2 hours, the maximum concentration of alcohol is seen in blood. The alcohol starts being excreted in urine. The concentration of alcohol in urine is 1.3 times higher than that of blood and is fairly constant. Once alcohol is in blood, it reaches all the fluids and tissues of the body. About 90 per cent alcohol is metabolised in liver by enzyme alcohol dehydrogenase at a rate of about 10–15 ml per hour. Some alcohol is converted into lipids and fats in the tissues. Rest of the alcohol is excreted through urine, lungs and sweat glands. The concentration of alcohol in breath can be measured. About 2100 ml of exhaled air contains the same amount of alcohol as in one ml of blood. Alcohol is a depressant of central nervous system. Only in small doses it causes euphoria and elation. Impairment of vision develops around 20–30 mg per 100 ml of blood. Alcohol also raises auditory threshold and reaction time. When applied to skin,

alcohol causes cooling and later redness and irritation. Alcohol has the power to dehydrate tissues by abstracting water. Dehydration ensues after drinking alcohol due to diuretic action.

Medico-legal Significance

Alcohol is consumed all over the world except in Islamic countries, on social events and gathering. People also take it alone or in company of friends and colleagues. Consumption of alcohol may bring a person into conflict with law.

Drunkenness

A doctor is called upon by police to examine a person who has consumed alcohol. He may be brought with following queries:

1. Whether a person has consumed alcohol or not?
2. Whether he is under the influence of alcohol or not.

The special Committee of British Medical Association, 1927 has described drunkenness as “An individual can be certified to be drunk only when there is evidence that he was so much under the influence of alcohol as to have lost control of his faculties to such an extent as to render him unable to execute safely the occupation in which he was engaged at that material time.”

In India, consumption of alcohol is not an offence. The Indian law comes into picture only when an individual does drunken behaviour after consumption. The law takes cognisance when individual behaves in such a manner as to become public nuisance, or poses a threat, or actually commits an act endangering the life or property of another person (or even his own). Such persons are arrested by police and brought before a medical practitioner for clinical examination.

The medical examination of the person brought for medical examination should be carried out on following lines:

1. Record date and time of examination. Note down names of constables who brought person for examination.
2. Name, age, sex, residential address and brief history should be taken. Ask about any illness or disability.
3. *Consent*: Consent should be taken after informing him. If the person refuses to give informed consent and he is under custody of police, examination can be done without consent also and samples can also be collected.
4. Two identification marks should be noted. Thumb impression should be taken.
5. State of clothing should be seen. It may be soiled by vomiting or incontinence. The character of speech should be noted whether thick, slurred or over precise. Orientation to time, place and person should be recorded. The character of handwriting should be seen.
6. Look for tachycardia, whether skin is dry, moist or flushed.
7. *Breath*: Smell of alcohol should be looked for.
8. *Eyes*: Appearance of conjunctiva to be noted whether congested or not. Reaction of pupils to light, size of pupils whether dilated or pin-point, are to be noted. Condition of extrinsic muscles regarding convergence should be noted. Strabismus and nystagmus should be looked for.
9. *Ears*: Hearing may be impaired.
10. *Gait*: Ask the person to walk across the room in a straight line. See for lurching or reeling and ability to stand with both eyes open and closed.
11. *Muscular co-ordination*: Ask the person to put index finger on nose (Finger nose test). See whether he can do it easily or not. Ask him to perform small functions like picking a coin from the floor, buttoning or unbuttoning clothes. See how he performs then.

12. *Reflex*: See knee and ankle reflex. Whether they are normal or depressed.
13. Do a complete physical examination. Urine sample and blood sample should be collected for laboratory investigation. The preservative for blood sample should be sodium fluoride and for urine sample should be phenyl mercuric nitrate.
14. *Opinion*: This should be expressed as follows:
 - (a) The individual examined has or has not consumed any alcohol.
 - (b) The individual examined has consumed alcohol and he is/is not under the influence of alcohol.
 - (c) The individual is under the influence of alcohol but he is/is not a public nuisance if kept at large.
The report should be finally signed by the doctor and handed over to police along with the sample of blood and urine.

Widmark Formulae

The amount of alcohol consumed by a person can be found out by the following formula:

$$a = c \times p \times r$$

where 'a' is amount of alcohol consumed by a person in grams, 'c' is the amount of alcohol in grams per kg estimated in blood, 'p' is the weight of the person in kg while 'r' is a constant value which is obtained by dividing the average concentration of alcohol in body by the concentration of alcohol in the body. This is a constant and its value for men is 0.085 and for women it is 0.055.

Alcohol and Sex

It is widely wrongly presumed that alcohol increases the sex desire but its not true. In low doses, the person may feel high desire as it causes inhibition of social pressure and euphoria but if alcohol is taken in large doses, it depresses the sex

desire. A well known saying summarises it as "alcohol provokes the provocation but takes away performance."

Alcohol and Accidents

It has been worldwide reported that there is increased incidence of road traffic accidents if a person drives under the influence of alcohol. It puts him and others in grave threat of accidents. In India, it is an offence to drive while alcohol is taken vide Section 185 of Motor Vehicle Act in which a person can be fined and may undergo imprisonment ranging from 6 months to 2 years. Many countries have set different blood alcohol concentration levels for allowing people to drive while under intoxication of alcohol. The limit is 20 mg per cent in Poland and Sweden, 50 mg per cent in Finland, Norway and Netherlands, 80 mg per cent in Denmark, Germany, UK, France, and Switzerland, 100 mg per cent in Ireland and 80 to 150 mg per cent in different states of USA. In India, the statutory limit is fixed at 30 mg per cent. But since breath analysing facilities are not available all over India, the drivers are being convicted only on the basis of medical examination.

Breath Analysers

These are instrument in which a person who is accused of driving under the influence of alcohol is asked to exhale the air from lungs by the police. Previously, the person was asked to blow into a plastic balloon which contained a solution of dichromate-sulphuric acid which would turn into green colour if alcohol concentration was more than certain level. Now we have sophisticated breath analysers which can sense alcohol levels with a very minute exhaled air and even in unconscious drivers by keeping them near their nose. The breath analyser directly gives the reading in blood alcohol concentration. It is based on the formula that 2100 ml of respired air contains the same amount of alcohol as present in one ml of blood.

METHYL ALCOHOL

The common names are wood spirit, wood naphtha and colonial spirit. It is clear, colourless volatile liquid with characteristic odour. It has a bitter taste. It is used as solvent in shellac and varnish manufacture and as an anti-freeze. It is also mixed with rectified spirit to make industrial methylated spirit which is used in arts, and manufactured as denatured spirit. It is also a part of embalming fluid, windshield washing fluid and leather dyes.

Symptoms

They usually develop within 1 hour of ingestion. Usual symptoms are dizziness, weakness, headache, vertigo, nausea, vomiting, abdominal pain and fixed and dilated pupils. Visual disturbances like photophobia and blurred vision are seen. The concentric diminution of visual fields for colour and form is seen followed by partial or total blindness due to retrobulbar neuritis, which in turn, is due to the toxic effects of formaldehyde on retinal cells. The formaldehyde is formed as a result of metabolism of methyl alcohol. On fundus examination, hyperemia of optic disc is seen followed by retinal oedema leading to optic atrophy and blindness. Severe metabolic acidosis follows. Tachycardia, hypotension and hypothermia are also seen. Death is due to respiratory failure.

Mechanism of Action

The methyl alcohol is metabolised in liver by alcohol dehydrogenase to formaldehyde, which is further metabolised to formic acid. It causes ocular toxicity and metabolic acidosis.

Fatal Dose

The usual fatal dose is 70–100 ml.

Fatal Period

The usual fatal period is 24–36 hours.

Treatment

Immediately gastric lavage should be done with 5 per cent sodium bicarbonate in warm water. 500 ml solution should be retained in the stomach at the end of lavage.

Antidote

Ethyl alcohol is the best specific antidote as it competes for the same alcoholic dehydrogenase enzyme for which methyl alcohol does. It prevents metabolism of methyl alcohol, which is then passed as such in urine. 10 per cent ethyl alcohol is administered intravenously in a dose of 10 ml/kg slowly over a time period of 30 minutes. It is maintained at rate of infusion 1.5 ml/kg/hour to maintain blood level of 100 mg per 100 ml of blood. The ethyl alcohol can be given orally also mixed in a fruit juice. The usual oral dose is 1 ml/kg of 95 per cent ethyl alcohol in 30 minutes which can be maintained at 0.25 ml/kg/hour.

Nowadays, some scientists are using 4-methyl pyrazole or fomepizole as antidote. It is a direct inhibitor of alcohol dehydrogenase and does not cause CNS depression. Sodium bicarbonate should also be given intravenously to combat metabolic acidosis. Hemodialysis is quite effective in removing methanol and its metabolites. Folinic acid may be given intravenously as it hastens the elimination of formic acid.

Post-mortem Appearance

The mucous membranes of stomach and intestine are congested. The lungs are congested, and oedematous. The pungent smell of methyl alcohol can be appreciated. Eyes may show retinal oedema. Cyanosis is quite prominent.

Medico-legal Significance

Mass poisoning of methyl alcohol is quite common in India. Methyl alcohol adulterated intoxicating beverages are sometimes sold to poor people who

cannot afford country liquor or Indian made foreign liquor. As a result of which mass tragedies occur. These are called **Hooch tragedies**. Sometimes, there is adulteration of country liquor with methyl alcohol and may cause mass deaths. These deaths keep on being reported in all leading newspapers every year. Sometimes, an alcoholic may consume methyl alcohol if he is not able to get ethyl alcohol.

CHLORAL HYDRATE

Chloral hydrate was previously used as a hypnotic. Nowadays, it is not used in clinical practice. It is sometimes used as adulterant in illicit liquor to enhance its intoxicating effect. It is commonly known as 'Mickey Finn or Knock out drops'.

Physical Features

It is colourless, crystalline, having a pungent banana smell, and a bitter taste. It is easily soluble in water and alcohol.

Symptoms

The common symptoms are nausea, vomiting, gastric irritation followed by hypotension, drowsiness, unconsciousness, loss of reflex and deep coma leading to death.

Metabolism

Chloral hydrate is well absorbed through stomach and intestine and is metabolised to trichloroethanol in liver by enzyme alcohol dehydrogenase. It is excreted in urine as urochloralic acid.

Treatment

Gastric lavage should be done immediately. Cardiac arrhythmias should be managed. The patient should be managed on conservative lines.

Medico-legal Significance

Accidental poisoning was common previously, when chloral hydrate was used as a hypnotic

medicine, due to overdose. Suicidal cases have been reported. Chloral hydrate has been used to stupefy the victims to facilitate commission of rape or robbery. It can easily be given in beer or whisky. Some people put it in their alcoholic drinks to increase intoxication. Homicide is rarely reported by chloral hydrate.

BARBITURATES

The barbiturates are widely used in clinical practice. They are commonly classified according to their duration of action. The classification is as follows:

1. **Ultrashort Acting:** Duration is less than 15–20 minutes. The common examples are thiopentone and methohexitone.
2. **Short Acting:** Duration is less than 3 hours. The common examples are hexobarbitone, pentobarbitone and secobarbitone.
3. **Intermediate Acting:** Duration is 3–6 hours. The common examples are amobarbitone, aprobarbitone and butobarbitone.
4. **Long Acting:** The duration is 6–12 hours. The common examples are mephobarbitone and phenobarbitone.

Chemically, barbiturates are derivatives of barbituric acid (2,4,6-trioxohexa hydroypyrimidine). Clinically they are used as sedative–hypnotic in sleep disorders. Ultrashort-acting barbiturates are a part of anaesthetic medications, and used everyday in operation theatres. Barbiturates, especially long-acting once, are used in treatment of epilepsy and other convulsant disorders.

Pharmacokinetics

After absorption either through oral route or intravenous route, they are distributed widely in tissues. Metabolism occurs in liver by oxidation resulting in formation of alcohols, ketones, phenols and carboxylic acid. These are excreted in urine as such or in the form of glucuronic acid conjugates. Some percentage of long-acting barbiturates like phenobarbitone is excreted in the urine as such.

Clinical Features

There are five stages in barbiturate poisoning as described by Sunshine and Hackett:

1. Awake, competent and normally sedated.
2. Sedated, reflex present, prefers sleep, answer questions when aroused, does not cerebrate properly.
3. Comatose and reflexes present.
4. Comatose and areflexia.
5. Comatose with respiratory and circulatory difficulty. Death occurs from respiratory failure.

The symptoms of barbiturate poisoning depend on many factors —

1. Dose—higher the dose, severe are the symptoms.
2. Short acting barbiturates are more toxic than others.

In fatal poisoning, blood level of 3 mg per 100 ml of blood is seen in cases of short acting barbiturates while it is 10 mg per 100 ml of blood in cases of long acting barbiturates.

If barbiturates are taken with alcohol, the effects are more due to synergism. Similar effects are seen with antihistamines. If recovery follows, residual depression may be seen. Paradoxical excitement is seen especially in elderly people. Hypersensitivity reaction in the form of localised swelling of eyelids, cheek or lip may be seen.

CHRONIC POISONING

It is sometimes seen in persons who are on medication. Over the time, therapeutic dose keeps on increasing to the level that person may get relief with 5–6 times the normal dose. The chronic addicts show poor judgement, loss of memory, skin eruption (cutaneous bullae), constipation, irritability, ataxic gait, stammering, cramps and orthostatic hypotension. Withdrawal symptoms are seen when the drug is withdrawn.

Fatal Dose

For phenobarbitone it is 6–10 gm while in cases of

amobarbitone, pentobarbitone and secobarbitone it is 2–3 gm.

Diagnosis

Barbiturates can easily be detected by thin layer chromatography by using samples of either urine or stomach contents. Gas chromatography is also very useful.

Treatment

The treatment of barbiturate poisoning is conservative and involves supporting of respiration and circulation. The control of hypothermia is a must. Treatment can be done in following ways:

1. *Gastric lavage*: It should be done within 4 hours of ingestion and may be attempted even up to 8 hours of ingestion, as sometimes ingested drug may form a mass resulting in delayed absorption and prolonged toxicity.
2. Repeated dose of activated charcoal is very effective.
3. Doxapram should be infused in severe poisoning with respiratory depression.
4. *Forced alkaline diuresis*: It is very useful only in long-acting barbiturates but not in short- and intermediate-acting barbiturates as they have high lipid portion coefficients, high protein binding and high dissociation constants.
5. Peritoneal dialysis is quite useful.
6. Hemodialysis is nine times more effective in long-acting barbiturates and six times more effective in short-acting barbiturates, as compared to forced alkaline diuresis. Haemoperfusion is also effective. Hemodialysis should be done in all cases of severe poisoning.
7. Some scientists have advocated the use of CNS stimulants like begemide and megimide, but their role is controversial and they are not used in clinical practice.

Post-mortem Appearance

Peripheral cyanosis may be seen along with barbiturate blisters on dependent parts of body. Froth may be seen at mouth and nose. Erosion or congestion may be seen in stomach and intestine. Lungs are intensely congested.

Medico-legal Points

Incidence of barbiturate poisoning has gone down as its use is now limited. Various cases are reported where doctors or paramedical workers have committed suicide by using short-acting barbiturates along with muscle relaxants. Thiopental is used as truth serum to extract confession or secrets during interrogation by inducing a state of hypnosis. The person may tell the truth or reveal crucial links to help investigation. This technique is called **Narcoanalysis** and is now allowed by courts in India to investigate hardened criminals.

Accidental poisoning is common in persons using barbiturates as medicines because of tolerance. Automatism is reported in chronic barbiturate use as the person may keep on taking medicine by thinking that he has not taken medicine. Homicidal poisoning is also reported.

BENZODIAZEPINES

The benzodiazepines are commonly used for the treatment of anxiety, insomnia and in treatment of convulsions, movement disorders and mania along with others drugs. The common benzodiazepines used are alprazolam, chlorodiazepoxide, clonazepam, lorazepam, etc.

Acute Poisoning

The benzodiazepines are one of the most safe drugs. Deaths have not been reported even when large doses are taken. The mild features include drowsiness, weakness and ataxia. In moderate to severe poisoning, vertigo, slurred speech, lethargy, nystagmus and coma may be seen. The

benzodiazepines act by lowering the potential difference between the interior and exterior of cell, causing inability of the cell to conduct nerve impulse.

Treatment

It involves the following measures:

1. **Gastric Lavage:** It should be done within 6–12 hours of ingestion. Activated charcoal may be given.
2. **Supportive Therapy:** It is the mainstay of treatment. Secure airways. Maintain circulation.
3. **Flumazenil Therapy:** Benzodiazepine antagonist flumazenil rapidly reverses the action of benzodiazepines. There is a dramatic improvement in anxiolytic, ataxic, anaesthetic and muscle relaxants effects of benzodiazepines. But duration of action is short lived (30 minutes to 1 hour). Repeated doses may be given to prolong effect. The recommended dose is 0.1 mg/minute in slow infusion to a total dose of 1 mg. The dose may be repeated after 1–2 hours if sedation occurs.

Chronic Poisoning

It usually occurs in patients who are on benzodiazepines for treatment. Long term use causes tolerance. The usual features are anxiety, insomnia, headache, tremor and paraesthesiae when drug is withdrawn.

Medico-legal Points

As fatalities are not reported, the benzodiazepines are not used for homicidal purposes. The person may take them for committing suicide in an impression that he may die with high doses.

Sometimes, benzodiazepines are used as a drug in drug facilitated sexual assaults. Here, the unsuspecting victim is given drug (like benzodiazepines) mixed in cold drinks or alcohol at a party. The person when gets drowsy, may be sexually assaulted. This is commonly called date rape and has been described earlier.

CHAPTER 37

Cerebral Poisons—Deliriant Poisons

Deliriant poisons act on the brain and cause delirium, i.e. confusion with altered sense of consciousness. The person may have delusions, hallucinations or excitement. The common examples include dhatura, cannabis and cocaine.

DHATURA

The plant grows all over India and is considered to be blessed by Lord Shiva. It is sometimes offered to Lord Shiva in *puja*. It belongs to the family Solanaceae. There are two varieties: first *Datura alba*, a white flowered plant and *Datura Niger*, a black or purple flowered plant. Both varieties have bell-shaped flowers and have spherical fruits which are covered with sharp spinous projections and have yellowish-brown seeds. Another variety, *Datura stramonium*, commonly called thorn apple, grows in high reaches of the Himalayas. All parts of the plant are poisonous but seeds and fruits are more poisonous. The active principles present in dhatura plant are hyoscine, hyoscyamine and traces of opium. The dried leaves of some dhatura plants are used in preparation of some medicines. The seeds of dhatura have resemblance to chilly seeds but they are very bitter in taste (Fig. 37.1).

Symptoms

The symptoms of dhatura poisoning are described in classic phrases like blind as bat, hot as hare, dry



Fig. 37.1 Dhatura plant along with fruit and seeds.

as a bone, red as beet and mad as wet hen. The common clinical features are described in the following “Ds”:

1. Dryness of mouth along with nausea and vomiting due to gastric irritation (dry as bone).
2. Dysphagia due to irritation of gut.
3. Dilated pupils with flushed appearance of face (red as beet).
4. Diplopia with red injected conjunctivae (blind as bat).
5. Dry, hot skin, sometimes rash may be seen (hot as hare).
6. Drunken gait.

7. Delirium—confusion, headache, hallucinations, delusions. Hallucinations of sight and hearing are common (mad as wet hen).
8. Drowsiness.
9. Dysuria—pain while passing urine.
10. Death due to respiratory failure.

Delirium in dhatura poisoning is peculiar. The person is restless and very excited. Sometimes, he mutters words or remains silent. Usually the person is noisy, tries to run away from bed, picks at bed clothes and tries to pull imaginary threads from the tip of his fingers. These are all symptoms due to anticholinergic effects of active principles present in the seeds.

Fatal Dose

About 50–100 seeds.

Fatal Period

About 24 hours.

Treatment

1. The gastric lavage should be done immediately with water or potassium permanganate. Since due to poisoning, there is decreased gastrointestinal motility, lavage is useful even in later stages. Activated charcoal may be given as it helps in reducing the absorption of toxins from gut.
2. The vital organs should be supported and taken care of.
3. *Antidote therapy*: Physostigmine acts as a physiological antidote and it reverses the effects of poisoning. It is given as 1–2 mg slowly intravenously over five minutes. The same dose can be repeated every ten minutes till cessation of life threatening condition. Indications for use of physostigmine are severe hallucinations and agitation, supra-ventricular tachycardia and uncontrollable convulsions. The disadvantage of physo-

stigmine is that it can precipitate convulsions and cholinergic crisis. So, it must be used with caution.

4. The hypothermia should be controlled by clothing.

Post-mortem Appearance

Dhatura seeds can be seen in stomach and intestine. The gut is entirely congested.

Medico-legal Significance

Dhatura is widely used as an stupefying agent. The extract of seeds is mixed with food and is given to unsuspecting persons with an intention to rob, rape or harm. Usually, the seed extract is mixed in *prasad* and is given to co-passengers in train with an intention to rob them. The extract may be given to children to stupefy them and kidnap them.

The seeds and leaves of the plant are mixed with tobacco or ganja and smoked in *chillum* (pipe). Sometimes, extract of seeds is added to alcohol to increase potency. Some people consume dhatura seeds as aphrodisiac but it is not effective as it does not have such properties. Dhatura seeds resist putrefaction, so they can be detected for a long time. Accidental poisoning is reported. Some *Sadhus* especially in the Himalayan region consume dhatura on a regular basis due to religious practice. Homicidal poisoning is rare but reported.

ATROPA BELLADONA

It is also known as deadly ‘nightshade’. This plant belongs to the family Solanaceae and grows mostly in the Himalayan range. The leaves, berries and root, all parts of the plant are poisonous. Atropine, hyoscyamine and belladonnine are the active principles present. The most important is atropine.

Symptoms

They are same as that described in dhatura poisoning.

Fatal Dose

80 grains of root is sufficient to kill a person.

Fatal Period

3–6 hours.

Medico-legal Significance

Accidental poisoning is common among children due to consumption of berries or seeds. Suicidal and homicidal poisoning is rare.

CANNABIS SATIVA

Cannabis sativa or Indian hemp grows wildly all over India and is also cultivated under government orders. The male and female plants are different. The female plant is taller about 4–6 metres and has darker and luxuriant foliage than the male. The word “cannabis” is used for the flowering and fruiting tops of the plant. It yields a sticky, amorphous resin called ‘cannabinone’. The active principles in this resin are mainly cannabinal a colourless oily liquid, cannabidiol, cannabinolic acid and many tetrahydrocannabinol isomers.

The following are the common forms in which the plant cannabis sativa is used:

1. **Bhang or Siddi, Patti or Sabji:** Bhang consists of dried leaves and flowering or fruiting shoots. Bhang is consumed all over India in religious festivals mainly during Holi. It is also a part of *thandai*, a beverage used in summer to cool off. Bhang leaves are usually rubbed on stone to be used in beverages and then it is mixed with sugar and pepper to form bolus which are then consumed.
2. **Majun:** This is a confection prepared by treating bhang with sugar, flour, milk and butter. It has a sweet taste. It is used in making sweets. Sometimes, dhatura is also mixed with majun to enhance intoxication.

3. **Ganja:** It is resinous extract of flowering tops or fruiting tops of female plant. It is mixed with tobacco and usually smoked in *chillum* (pipes).
4. **Charas:** It is also known as hashish. It is a concentrated resin obtained from leaves and stem of the plant. It is dark green or brown in colour. It is smoked with tobacco in pipes. It is the most potent intoxicant of cannabis.
5. **Marijuana (Marihuana, pot, weed or grass):** The cut leaves and flowering tops are crushed and smoked in a pipe along with tobacco or in cigarette. The common word is grass or joint.

Symptoms

The effect of *C. sativa* is more when it is inhaled rather than ingested in food. There are two stages of symptoms:

1. **Stage of Inebriation and Release of Inhibitions:** There is immediate excitement, euphoria with drowsiness and disorientation. There may be uncontrollable laughter, marked increase in appetite, particularly of sweets and muscular incoordination. The perception of time and space is lost. Hallucinations are common. Tachycardia and conjunctival congestion are seen. If large doses are taken, nausea, confusion and delusions may be seen. The characteristic smell of burnt rope is observed which is typical of cannabis preparations. The ataxia, dryness of mouth, and numbness in skin may be seen.
2. **Stage of Narcosis:** If the dose is severe and the person does not recover from stage I, he passes into the stage of narcosis with bloodshot eyes. He goes into deep sleep. In majority of the time there is recovery after prolonged sleep. Death is very rare but can occur due to respiratory failure if large doses are taken.

Chronic Poisoning

It usually occurs in persons who are chronic users of cannabis and are addicted to it. The common symptoms are loss of appetite, general weakness, emaciation, trembling, impotence and, moral and mental deterioration. Mental changes include apathy and psychosis. The person may have delusions and hallucinations. Gynaecomastia and increased susceptibility to infections are seen.

Fatal Dose

Usually, death is not reported. Death may occur if cannabimimetic is given intravenously in a dose of 30 mg/kg body weight.

Fatal Period

Since death is very rare, fatal period is uncertain.

Post-mortem Appearance

Nothing characteristic. The organs may be found to be congested. Burnt rope-like smell may be observed due to cannabis.

Treatment

Mostly symptomatic. Do the gastric lavage if the person has ingested. Keep respiration and circulation maintained. Recovery is seen with prolonged sleep.

Medico-legal Significance

Most of the time, ingestion and inhalation of cannabis is voluntary. Sometimes, bhang may be used to stupefy a person to loot, rape or commit a crime. Cannabis is a drug of abuse commonly used all over the world. Physical dependence is uncommon but some withdrawal symptoms in form of insomnia, irritability, anorexia may persist for days.

Run-amok

This is a temporary insanity observed in cannabis abusers who are consuming it for a long time. In this, a person may become violent and may start running wildly. He may stab or shoot anyone who is coming in the way. Spate of stabbing or shooting is due to disturbed state of mind. Such a person may commit suicide later, or is shot by the police who try to control him but shoot him when not possible.

COCAINE

The common names for cocaine are crack, snow, coke, cadillac, and white lady. Cocaine is an alkaloid derived from leaves of plant *Erythroxylon coca*. This plant originally grew in South America but now is cultivated in India, Sri Lanka and Java. Nowadays, cocaine is synthetically made. An ester of benzoic acid and a base containing nitrogen is synthetic cocaine. It is a colourless, odourless, crystalline substance with a bitter taste. It dissolves easily in alcohol but not in water. Once taken, it causes numbness of the tongue and mucous membrane of mouth.

Cocaine hydrochloride is used in medical practice. It is used as local anaesthetic in ophthalmic practice, dental and in minor operative procedures. Previously, cocaine was part of the Brompton cocktail which was given to relieve pain in terminal cases of cancers. Alcohol, morphine, and chlorpromazine were other constituents of this cocktail.

Acute Poisoning

Cocaine can be taken into the body by insufflation (snorting or sniffing), by smoking, ingestion and by intravenous route. There are three stages in acute poisoning:

Stage I: It is the stage of early stimulation. There is sense of well being, euphoria, excitement, and talkativeness. Dryness of

mouth and throat is seen. Tachycardia, hypertension and hyperthermia are seen. Vertigo and nausea may be there. There is numbness in mouth.

Stage II: It is a stage of advanced stimulation in which hallucinations are seen. Vomiting, muscle twitching, hyperthermia (cocaine fever), dyspnoea, and convulsion may be seen. Circulatory and respiratory systems start failing.

Stage III: It is a stage of depression where paralysis of muscles, loss of reflexes, and coma are seen. Death may occur.

Fatal Dose

About 1.25 gm, if ingested by mouth. Very low doses may kill if cocaine is given intravenously or hypodermically.

Fatal Period

It may vary from a few minutes to a few hours depending on the dose.

Treatment

Gastric lavage should be done immediately. Activated charcoal may be given. The rest of the treatment is on conservative lines. Convulsions should be managed with barbiturates or benzodiazepines. Hypertension should be tackled with beta blockers. Ice water bath may be given for hyperthermia. The cardiac arrhythmias should be controlled with drugs.

Chronic Poisoning (Cocainism)

Chronic abusers of cocaine become addictive to cocaine. Since cocaine is very costly, mostly rich people become addicted to it. Usually, it is snorted or snuffed. Smoking (crack) is also popular. Once the person consumes cocaine, there is euphoria (rush) followed by depression (crash) after an hour. The person may feel compelled to take more cocaine.

Symptoms

Usual symptoms are anorexia, pale face, sunken eyes, insomnia, digestive disturbances, impotence, defective memory, physical and moral degeneration, mydriasis, tachycardia, hypertension and tachypnoea. Mental changes include hallucinations, delusions of persecution, depression and derangement of special senses.

Magnan Symptoms (Cocaine bugs)

Tactile hallucinations are common. Feeling of crawling of insects on skin or sand bags lying under the skin are reported. There may be marked itching on the skin. The tongue and teeth may be jet black. Chronic complication of nasal insufflation in the form of rhinitis, nasal erosions or perforation or sinusitis may be seen. Chronic cough or bronchitis may be seen due to smoking. Due to chronic use through intravenous route, the person may have infection and thrombosis of vein. Since cocaine users share needles too, they may have high risk of AIDS infection.

Treatment

The chronic addicts of cocaine need hospitalisation to control withdrawal symptoms.

Medico-legal Significance

Accidental deaths have been reported with overdoses. Cocaine is widely used as drug of abuse. Sometimes, it is smuggled across countries by individuals by swallowing several small plastic bags or balloons or condoms filled with cocaine and then they take flight to other countries. Once reaching the destination, they take purgative to pass these bags through stool. Sometimes, small packets are kept in rectum or vagina. Once these packets are retrieved, they are cleaned and sold at very high prices. This process is called **Body packer syndrome** or **Bodystuffing**. Sometimes, these packets rupture inside stomach or rectum and a large dose of cocaine is released. The person may

die because of such dose. Such persons are sometimes caught at airport and may be brought for medical examination. X-ray and ultrasound can be done to see bags and purgative or enema is given to retrieve such bags. Sometimes, prostitutes inject a solution of cocaine into vagina. This gives the individual who is having sex with them a sense of local constriction and hence more pleasure. But the person can get intoxicated as cocaine gets absorbed.

Cocaine can be identified in urine by thin layer chromatography, as some parts pass into urine. Suicidal poisoning by cocaine is reported. Homicidal poisoning is rare.

AMPHETAMINE

It is a psychotropic drug. A psychotropic substance is defined as that which affects psychic function, behaviour, or experience of an individual. Amphetamine was first synthesised in 1887. It was used in medicine for therapeutic effect for the treatment of narcolepsy, attention deficit disorder and some forms of hypotension. But since it was misused too much, amphetamine is not used for therapeutic purposes now. Chemically it is phenyl propanolamine. Amphetamine is also used for reduction of weight. Amphetamine is a very powerful stimulant of CNS and circulatory system. It enhances the synaptic concentration of dopamine and norepinephrine either by direct release from storage vesicles or by inhibition of re-uptake.

Acute Poisoning

Methamphetamine is commonly used as stimulant by both oral and intravenous route. Sometimes it is also smoked.

The major features of acute poisoning are due to CNS stimulation and sympathomimetic actions. CNS symptoms include euphoria, restlessness, anxiety, seizures and coma. Intracranial haemorrhages may occur due to hypertension and vasculitis. Systemic features include sweating, tremors, muscle fasciculations, rigidity, tachycardia, hypertension, cardiac arrhythmias and myocardial infarction.

Gangrene may also occur due to vasospasm caused by amphetamines. Hyperthermia may also be there. Renal failure may occur.

Chronic Poisoning

It is seen in chronic abusers. Amphetamine psychosis is reported in which stereotyping is seen. In this, person may keep on doing repetitive activities like grooming, cleaning, rearranging. Paranoid behaviour along with delusions is seen. Visual hallucinations are reported. Gilles de la Tourette syndrome seen in chronic poisoning is characterised by tics, eyes blinking and jaw jerks. Cardiomyopathies and intracranial haemorrhages are also observed.

Fatal Dose

About 250 mg.

Treatment

The treatment is symptomatic. Gastric lavage may be done if drug is ingested. Treat agitation with haloperidol. Hyperthermia is controlled by a cold bath. Seizures may be controlled with anticonvulsants.

Medico-legal Significance

Since amphetamine is a very potent CNS stimulant, it is widely used for keeping awake for a very long time. It is abused by medical students, truck drivers, night workers, etc, for waking long hours to complete work. It is also used by young persons in rave parties to keep on dancing all night. Some of the derivatives of amphetamine are called designer drugs, love drugs, ecstasy, or eve.

LYSERGIC ACID DIETHYLAMIDE (LSD)

The common street names are acid, purple haze, white lightning or microdot. It is crystalline, colourless, tasteless and water soluble. (It is a very

strong hallucinogen known till date.) It was widely used by hippies in 1960s.

Clinical Features

LSD is usually taken orally but it can be dissolved and snorted for quick results. The initial features are nausea, flushing, chills, tachycardia, hypertension, piloerection and tremors. Slowly psychic affects starts in. It includes affective liability, time distortion, visual illusions, sound magnification and distortion and a blending of sensory modalities called synesthesia. It is like feeling colours and seeing of sounds. The hallucinations are very pleasant and dreamy. It may last for 6–12 hours. If strong dose is taken, death may occur due to coma, respiratory arrest, hypertension or convulsions.

Fatal Dose

About 500 μ gm is fatal.

Treatment

Do gastric lavage and symptomatic treatment.

PHENCYCLIDINE

The common names are angel dust, peace pill, hog, rocket fuel, etc. It was initially marketed for veterinary use as an anaesthetic agent, later it was widely abused in America. It is not very popular in India. It can be snorted, smoked, ingested or injected. It produces generalised loss of pain perception. It has also CNS stimulant affect.

Clinical Features

Mild intoxication causes lethargy, euphoria, hallucinations and occasionally violent behaviour. Nystagmus both horizontal and vertical is commonly seen. Severe intoxication causes hypertension, hypothermia, tachycardia, seizures and coma. Self-destructive behaviour is sometimes seen.

Toxic Dose

150–200 mg of phencyclidine is fatal while street dose in 1–6 mg.

Medico-legal Significance

Phencyclidine is commonly used as drug of abuse along with other drugs like marijuana leaves or cocaine.

Spinal Poisons

STRYCHNOUS NUX VOMICA

It is also called *Kuchila*. It belongs to family Loganiaceae. It grows in Tamil Nadu, Malabar and Uttar Pradesh. The ripe fruit of plant contains seeds which are very poisonous (Fig. 38.1). Nux vomica seeds are flat, circular disc, or slightly convex on one side and concave on the other. The size varies from 2.2 to 2.5 cm and is about 0.6 cm in thickness. The seeds are ash-grey in colour and have a shining surface with short hair. The seeds are tough, possess no odour and are very bitter in taste. Strychnine and brucine are the main active principles along with strychnic, gastric or caffeotannic acid. A glucoside named loganin is also present in the seeds. The bark, wood and leaves of the plant contain only brucine.

1. **Strychnine:** The chemical formula is $C_{21}H_{22}O_2N$. It is colourless, odourless, seen in rhombic prism form. It has very bitter

taste. It dissolves in alcohol but not in water. Strychnine is a part of several vermin killers. It is a respiratory stimulant and rodenticide. Strychnine is mixed with some food material and then used as rodenticide.

2. **Brucine:** The chemical formula is $C_{23}H_{26}O_4N_2$. It is also colourless and has prismatic crystalline form and a bitter taste. It resembles strychnine in physiological action but it is only one-eighth poisonous as compared to strychnine.

Mechanism of Action

Strychnine is a spinal poison. The main site of action is anterior horn cells. It acts by competitively antagonising the inhibitory neurotransmitter glycine by blocking its postsynaptic uptake by brain stem and spinal cord receptors. GABA, the neurotransmitter for pre-synaptic inhibitory neurons is not affected by strychnine.

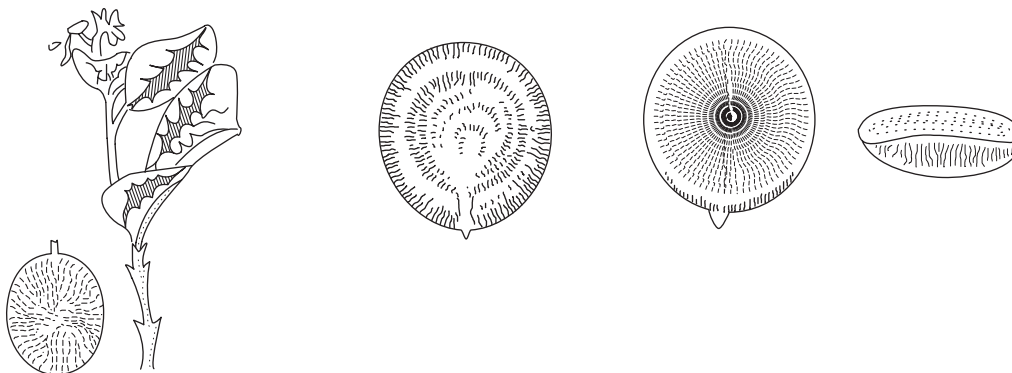


Fig. 38.1 Nux vomica plant along with seeds.

Symptoms

Nux vomica seeds are effective only when they are crushed or chewed before swallowing. As the pericarp is quite hard and indigestible, if whole seeds are taken through mouth without chewing, no poisoning symptoms are seen. The following are the main features:

1. A severe nausea is seen, vomiting may be there as the taste is very bitter.
2. Since the whole nervous system is excited, convulsions affect all the muscles at a time. Firstly clonic convulsions are seen, later tonic convulsions also follow. They keep on coming and intervals become shorter and paroxysm longer.
3. Face is cyanosed, wears an apprehensive look of impending death. Eyes are staring and eye balls become prominent. The pupils are dilated. The facial features are drawn into a grin (**Risus sardonicus**). It is due to spasm of facial muscles. The froth may be seen on the face.
4. The body may be seen arch-shaped in following postures —
 - (a) **Opisthotonos**: Hyperextension. The person may be resting on heels and occipit.
 - (b) **Emprosthotonos**: The spasm of abdominal muscles may bend the body forward.
 - (c) **Pleurothotonos**: The body may be flexed to one side.
5. The person is conscious and mind is clear till death.
6. There is an immense reflex excitability. Even a small stimulus like light or noise or movement of the body may throw it into a spate of convulsions.
7. Death usually occurs due to asphyxia as respiration is affected by muscle spasm.

The symptoms of strychnine poisoning closely resemble tetanus poisoning. The differences are given in Table 38.1.

Fatal Dose

The usual fatal dose is 60–100 mg of strychnine. One crushed seed is fatal.

Fatal Period

The usual fatal period is 1–2 hours.

Treatment

Nux vomica poisoning can be treated by following methods:

1. Immediately shift the patient to a dark room. No noise or any stimulus to be aroused to excite convulsions.
2. Secure airways. Start artificial respiration and oxygen therapy.

Table 38.1 Differentiating features of strychnine and tetanus poisoning

Features	Strychnine poisoning	Tetanus poisoning
1. History	Circumstantial evidence of poisoning, ingestion of food	History of injury
2. Onset	Sudden	Gradual
3. Fever	Not usual	Usually present
4. Affection of muscles	All muscles are affected simultaneously	Not all muscles affected simultaneously
5. Rigidity	Relaxation of muscles seen in between convulsions	Sustained rigidity even between convulsions
6. Chemical analysis	Strychnine may be demonstrated	No poison is detected. Microbiological test positive

3. Convulsions should be controlled with short-acting barbiturates like sodium pentobarbital or by benzodiazepines like diazepam.
4. When spasms are under control, do the gastric lavage with potassium permanganate.
5. To enhance excretion of strychnine, acidification of urine can be done.
6. Maintain patient on diazepam till convulsions are completely gone.

Post-mortem Findings

Rigor mortis sets in early but persists for a longer time. The mucous membrane may show congestion or erosion. The features of asphyxial death are seen. Post-mortem caloridity may be seen in some cases. Strychnine resists putrefaction and hence can be detected by chemical analysis long after death. In addition to routine viscera, heart, brain and spinal cord should be preserved in all cases of suspected poisoning.

Medico-legal Significance

Strychnine was previously used as purgative, appetite suppressant, aphrodisiac and a constituent of “nerve toxins.” Nowadays, it is not used for medicinal purposes. Strychnine is used as rodenticide and for killing dogs. Sometimes, nux vomica seeds are used for killing cattle. Suicidal poisoning is rare but some cases of homicidal poisoning have been reported. Accidental poisoning has been reported on occasions. Strychnine is sometimes used as an arrow poison. Strychnine is a cumulative poison as it retards its own secretion by contraction of renal vessels.

PERIPHERAL NERVE POISONS

These poisons act on motor end of nerve terminals. The most important among this group are curare and conium. Poisoning by them is quite rare.

Curare

It is a black resinoid mass obtained from bark and wood of the plant *Strychnos curare*. The active principles are curarine and curine. They act by blocking the action of acetylcholine by competitive inhibition at neuromuscular junction.

Symptoms

Curare is poisonous only when injected. If given orally, it does not produce any symptom. When injected, it first affects the muscles of toes, ears and eyes and then those of neck and limbs. Finally, it affects muscles of breathing. Death occurs due to respiratory paralysis. Death is quite fast. Consciousness is retained till the end. Other symptoms include headache, vertigo, mydriasis and blurred vision.

Fatal Dose

30–60 mg.

Fatal Period

Few hours.

Treatment

Ligature should be tied proximal to the site of injection to retard absorption. Atropine 0.6–1.2 mg followed by neostigmine 5–10 mg intravenously should be given. Respiration and circulation should be taken care of.

Medico-legal Significance

D-tubocurarine is used to facilitate skeletal muscle relaxation during general anaesthesia. Curare may be used in strychnine poisoning, tetanus and ECT therapy in psychosis. Curare is also used as arrow poison by tribals in South America.

Conium Maculatum (Hemlock)

It is also called Socrates poison as he was given this to die. Hemlock, is a term loosely applied to

several plants and trees of toxicity. The commonest is *Conium maculatum*. It is a weed-like shrub belonging to family Apiaceae. The root of this plant is very toxic along with all parts of plant. They contain many alkaloids chiefly coniine, conhydrine and N-methyl coniine.

Symptoms

Ingestion of fresh leaves causes nausea, heart burn and may give mousy odour to breath. Vomiting, gastric irritation and diarrhoea may be seen. Later, it causes tremor, ataxia and ascending paralysis of the body. Miosis may be seen. Progressive motor paralysis causes death from respiratory failure. Bradycardia and hypotension may be seen.

Fatal Dose

60 mg of coniine.

Fatal Period

Few hours.

Treatment

Gastric lavage and supportive treatment.

Medico-legal Significance

Poisoning may be due to ingestion or injection. Hemlock was known as state poison in ancient Greece. Famous philosopher Socrates was given this state poison to drink and die.

Accidental poisoning has been reported as root of the plant resembles wild carrot and a person may consume it by mistake.

Cardiac Poisons

TOBACCO (*NICOTIANA TABACUM*)

Tobacco plant is a native plant of America but now it is widely grown all over India. It belongs to the family Solanaceae. Tobacco is largely consumed in India. The dried leaves are smoked in form of cigarettes or in a *hookah*. Tobacco leaves are mixed in *paan* or they are mixed with lime and taken in form of *kheni*. *Kheni* is widely consumed in parts of north India, mainly Uttar Pradesh and Bihar. Many companies manufacture *bidi* or cigarettes made of dried tobacco leaves.

Nicotine and nicotianine are the two active principles found in tobacco:

1. **Nicotine:** The chemical formula is $C_{10}H_{14}N_2$. It is present in all parts of the plant but more in leaves. Consumption of nicotine firstly causes stimulation and then depression of vagal and autonomic ganglia. It also stimulates initially cerebral and spinal centres but later paralyses them. Initially, there is pupil contraction but later dilatation is seen. The workers involved in industries like cigarettes manufacturing may suffer from its toxic effect. Nicotine is a colourless, volatile hygroscopic, oily, natural liquid with a burning acrid taste. It is soluble in water and alcohol.
2. **Nicotianine:** It is also a volatile crystalline substance but non-toxic.

Acute Poisoning

If tobacco leaves are ingested by oral route, it causes severe gastric irritation. There is a severe burning pain in mouth and throat followed by salivation, nausea, headache, vomiting and severe diarrhoea. The smell of tobacco can be appreciated in breath. Slowly giddiness, faintness, muscular weakness, tremors, cold sweat and loss of consciousness is seen. Hearing and vision are affected. Pupils are first contracted but later, they are dilated. The pulse becomes rapid and cardiac arrhythmia are seen. Blood pressure rises. If a large dose is taken, pulse may become slow later on. The respiratory system is affected and the person may die due to respiratory failure. It happens due to paralysis of respiratory muscles. Sometimes, delirium, convulsions and areflexia are also seen.

Fatal Dose

In adults the lethal dose is 40–60 mg. 15–30 gm of crude tobacco is fatal, if taken orally. A cigarette contains about 10–20 mg of nicotine but by smoking only 1–2 mg is taken inside.

Fatal Period

If swallowed, nicotine may cause death in 10–15 minutes.

Treatment

The conservative treatment should be started at once. The gastric lavage should be done immediately with warm water containing powdered charcoal, tannin or a solution of potassium iodide. These drugs can render the alkaloid insoluble. If these are not available, lavage with potassium permanganate can be done. In the initial stages of mild to moderate intoxication, atropine can be given. But in severe cases, atropine is useless. Oxygen inhalation, artificial respiration and control of convulsions are must. Cardiac arrhythmias should be controlled with drugs.

Chronic Poisoning

Chronic poisoning with tobacco is prevalent all over the world due to heavy smoking. It may also be seen in workers working in tobacco factories. Chronic cough and bronchitis are common features. Due to smoking, pulmonary functions are retarded. There is a decreased ventilatory capacity. High risk of lung cancer is there. Due to heavy smoking, there is increase in coronary heart disease. Hypertension, myocardial infarction and depressed cardiac functions are seen. There is a high incidence of sudden death in chronic smokers.

The persons who chew tobacco either with lime or in *paan*, have a high incidence of oral cancers and peptic ulcers leading to cancers. Mucosa cancers, lip cancers and oesophageal cancers can be caused and high incidence is reported.

Dermatitis may be seen on hands and face of factory workers who are exposed to tobacco. The eyes may be affected. Amblyopia, commonly called 'tobacco amblyopia', is seen. Cardiac arrhythmias are quite common.

Medico-legal Significance

Accidental poisoning among children may be seen as they may ingest cigarette or tobacco leaves by mistake. Sometimes, they may also suffer after drinking *hookah* water which contains high

concentration of nicotine. Suicidal and homicidal poisonings are rare. Tobacco was earlier used for infanticide or to procure criminal abortion. Putrefaction has no effect on nicotine. So, nicotine can be detected even after death for a long time.

DIGITALIS PURPUREA

This plant belongs to the family Scrophulariaceae, grown in India especially in Kashmir. The root, leaves and seeds of this plant contain digitoxin, digitalin, and digitalien as active principles.

Symptoms

Initially, gastrointestinal symptoms are seen in the form of anorexia, thirst, nausea, vomiting followed by abdominal pain. Diarrhoea may be seen. Later, cardiac symptoms appear in the form of fainting, presence of arrhythmias, extra systoles. Initially, pulse may be fast, but later slows down. Heart block may be seen. ECG changes in form of flattened or inverted T-wave, depressed S-T segment, prolonged PR interval, heart block and ventricular tachycardia may be seen. The pupils may be dilated. Visual disturbances like fleeting spots, yellow or green vision may be there. Drowsiness and coma follows. Delirium may be followed by hallucinations or convulsions. Death occurs due to ventricular fibrillation.

Fatal Dose

2–3 gm of digitalis.

Fatal Period

Variable from a few hours to a day.

Treatment

Gastric lavage should be done and activated charcoal is to be given. Correct hypokalaemia, hypercalcaemia and hypomagnesia. For bradycardia, atropine may be given. Lignocaine and phenytoin are indicated for control of arrhythmias. Fab fragments are quite useful.

Medico-legal Significance

A few accidental cases have been reported in medical practice. Digitalis is a cumulative poison and its toxicity may be seen in chronic users suddenly without any increase in dose. Suicidal and homicidal poisonings are rare.

NERIUM ODORUM (KANER OR WHITE OLEANDER)

This plant belongs to the family Apocynaceae and is commonly known as white or sweet scented oleander. Its white or pink flower is commonly given as offerings in temples. All parts of this plant are poisonous. The active principle, Nefrin, a glycoside has been isolated from it. It is pure, white and has digitalis-like action. The leaves, bark and flowers of this plant are used in treatment of skin diseases, wounds, snake bite and gynaecological conditions.

Symptoms

The actions are like that of digitalis as mentioned earlier.

Fatal Dose

Not known.

Fatal Period

Death may occur in 24–36 hours.

Treatment

Same as that digitalis.

Medico-legal Significance

Sometimes, the root is used in the treatment of venereal diseases by quacks. In such conditions accidental poisoning can occur. Criminally, the root

is used as abortifacient both as local application and ingestion. Suicidal poisonings are reported. It can be also used as cattle poison.

CERBERA THEVETIA (YELLOW OLEANDER)

It is also called *pila kaner*. It belongs to the family Apocynaceae and is grown widely in gardens. It has yellow bell-shaped flowers and a green fruit with a nut. The plant is highly poisonous. The active principles namely: glycoside thevetin and cerberin, are present in the milky juice of the plant which exudes from all parts of the plant.

Symptoms

The actions are similar to those of digitalis as mentioned earlier.

Fatal Dose

Uncertain.

Fatal Period

Uncertain.

Treatment

On similar lines as in the case of digitalis.

Medico-legal Significance

Roots and seeds are used for criminal abortion or for suicidal/homicidal purposes. The seeds can be used as cattle poison.

ACONITE (MITHA ZAHAR)

The various names of this plant are *Aconitum napellus* or monk's hood or wolf's bane or blue rocket or *mita zahar* or *dudhia bish* (Fig. 39.1).



Fig. 39.1 Aconite root.

It belongs to the family Ranunculaceae and is grown all over the world. All parts of this plant are poisonous but root is mainly used as a poison. The root is usually 5–10 cm long, dark brown from outside and whitish and starchy internally when freshly cut. It is odourless but imparts a sensation of tingling and numbness to tongue, lips and mouth when chewed. The height of the plant is 2–6 feet.

The active principle in the root and other parts is mainly aconitine besides picroaconitine, aconine and other alkaloids combined with aconitic acid. Aconitine forms colourless, transparent rhombic crystals and is not soluble in water.

Mechanism of Action

Aconitine first stimulates and then depresses peripheral termination of sensory and secretory nerves, CNS, CVS, skeletal and smooth nerves. The consciousness remains clear till death as higher centres are not affected.

Indian Species of Aconite

There are various species of aconite which grow in the Himalayas. *Aconitum chasmanthum*, which is

known as *Bish* or *Bikh*, is commonly marketed in Kolkata. The root of Indian species of aconite looks like black, plump, heavy tuber usually 5–10 cm long when it is dried and stepped in oil. It has a disagreeable smell. It is commonly called *Bish* or *Bikh* or *Telyabish*. It is used by *vaid*s and *hakim*s in the treatment of various diseases like rheumatism, neuralgia and paralysis.

Symptoms

The symptoms appear in 10–15 minutes. Initially, there is a sweet bitter taste followed by severe burning and tingling of lips, tongue, mouth and throat followed by numbness and anaesthesia of these parts. Gastric irritation symptoms like nausea, pain in the abdomen, vomiting starts but diarrhoea is rare. Tingling and numbness starts spreading all over the body. The person feels quite uneasy. Initially pupils contract and dilate alternately but finally dilate. Diplopia and impairment of vision is seen. Vertigo, restlessness, difficulty in speech, pain and weakness of muscles twitching and spasm of muscles are common symptoms. Blood pressure starts falling, pulse is low but slow, feeble and irregular. Respiration becomes slow and laboured. Death may occur due to respiratory failure or ventricular fibrillation. ECG changes include ectopic beats, bundle branch blocks and ventricular tachycardia. Consciousness is retained till end in most cases, but in some cases delirium or convulsions or coma may be seen.

Fatal Dose

About 2 gm of aconite root is fatal.

Fatal Period

It may range from a few hours to one day.

Treatment

Gastric lavage should be done with a solution of animal charcoal or tannic acid or milk. Manage the patient conservatively. Atropine should be given for

bradycardia. Cardiac arrhythmias should be controlled with xylocaine. Artificial respiration should be started if needed.

Post-mortem Appearance

Nothing unusual. Pieces of aconite root can be seen in the stomach.

Medico-legal Significance

Accidental poisoning is reported if aconite root is mistaken for domestic radish root. Aconite root is widely used in Indian medicine. Suicidal and homicidal poisoning have been reported. Aconite root is also used as an arrow poison by tribals in Nepal and Assam. These arrows are used to kill animals. Urine should be preserved in all suspected homicidal or suicidal poisoning as aconitine is mainly excreted in urine. Small amounts of aconitine can also be found in saliva, sweat and bile. Aconitine is not stable and is easily destroyed by putrefaction. Sometimes, aconite root is used for enhancing intoxicating properties of liquors by addicts. It is also used as an abortifacient.

CYANIDE (HYDROGEN CYANIDE, HCN)

Cyanide is one of the most powerful poisons in the world. It can kill in seconds. Most cases of fatalities occur either due to inhalation or ingestion.

Hydrocyanic acid is quite common in nature. It is found in combination in the leaves of cherry-laurel, in bitter almonds, in the kernels of the common cherry, plums, apricot, peach and other stone fruits. It is also found in ordinary bamboo shoots, in certain oil seeds and beans. These plants contain a glucoside named amygdaline, which in presence of enzyme and water is converted into hydrocyanic acid. Hydrocyanic acid forms salt with metals. Potassium or sodium cyanide, mercuric cyanide and silver cyanides are used in photography, electroplating, case hardening of steel, silver and gold processing and dyeing. These

salts are soluble in water and are very toxic. Calcium cyanide, magnesium cyanide and cyanogen chloride are used in mining industry.

Cyanide is also used in plastic industry. Hydrocyanic acid is not found in commercial but only in chemical laboratories. It is used for fumigating houses, ships, etc. Hydrocyanic acid is colourless, possesses a characteristic smell of bitter almonds or peach kernels. The ability to smell cyanide is genetically owned as only some persons can smell cyanides, not all. Sodium nitroprusside, a cyanogen, is commonly used in the treatment of hypertension. Cyanides are also used in illegal manufacture of phencyclidines. Compounds like ferrocyanide or ferricyanide do not release significant amounts of cyanide. So, they only cause gastric discomfort.

Mechanism of Action

The toxicity due to cyanide is caused by inhibition of cytochrome oxidase enzyme by formation of cytochrome oxidase-cyanide complex. It causes paralysis of electron transport system leading to cellular hypoxia, as oxygen cannot be utilised by the tissues. Due to blockade of cytochrome oxidase enzyme, pyruvate is converted into lactate causing severe metabolic acidosis. The death occurs due to cytotoxic hypoxia.

Symptoms

The poisoning can occur due to inhalation (in this, death may occur in minutes), ingestion, or through skin or mucous membrane absorption (death may occur in 3–4 hours). The common route of poisoning is ingestion. The first symptoms are smell of bitter almonds in breath (20–30 per cent of population cannot appreciate this smell). There is acidic and burning taste, throat numbness, salivation, frothing at mouth, nausea and vomiting with substernal and epigastric pain. The involvement of CNS causes dizziness, confusion, vertigo, headache, sweating, anxiety, drowsiness, seizures, paralysis and finally death.

The involvement of respiratory system causes initially, tachypnoea and dyspnoea as a result of stimulation of respiratory centres and carotid chemoreceptors caused by local hypoxia. Later bradypnoea, hypopnoea and irregular respiration (a short inspiration and prolonged expiration), and pulmonary oedema is seen. Cyanosis and respiratory arrest follows. In cardiovascular system, initially hypertension along with reflex bradycardia, and sinus arrhythmia is seen. Later hypotension, tachycardia and arrhythmias are seen. ECG may show non-specific QRS and ST-T changes. Severe lactic acidosis is seen. Since venous oxygen tension is almost equal to arterial oxygen tension due to non-dissociation of oxygen, venous blood appears as red as that of arterial blood. If fundus is examined, retinal arteries and veins would appear equally bright red.

Chronic Poisoning

It is seen in photographers, gilders and workmen who handle cyanides. The chief symptoms are headache, vertigo, loss of appetite, nausea, constipation, bad breath, dyspnoea and anaemia.

Fatal Dose

50–200 mg of potassium or sodium cyanide is sufficient to kill.

Fatal Period

2–10 minutes.

Treatment

Time is the key factor in management of cyanide poisoning. The patient should be ventilated with 100 per cent oxygen using Ambu bag. The important step in the treatment of cyanide poisoning is to produce methaemoglobinaemia. Immediately, place broken amyl nitrite pearls under the patient's nose for 15–30 seconds every minute.

Immediately inject sodium nitrite intravenously and discontinue the pearls. Administer 10 ml of 3% sodium nitrite at the rate of 2.5–5 ml per minute. Nitrites cause hypotension which should be managed with fluids or drugs. Nitrites cause a state of methaemoglobinaemia which dissociates cyanide from cytochrome oxidase by forming cyanomethaemoglobin. After nitrites, sodium thiosulphate in a dose of 50 ml of a 25 per cent solution should be given. It converts cyanide from cyanomethaemoglobin into nontoxic thiocyanate which is excreted through urine.

Once the patient is stabilised, gastric lavage can be preformed. The activated charcoal can be given initially and at the end of lavage. The gastric lavage may be done either by potassium permanganate or sodium thiosulphate.

Another antidote which can be used is kelocyanor. It is dicobalt ethylenediaminetetraacetic acid (dicobalt edetate). It also chelates cyanide. It is given in the dose of 300 mg intravenously over three minutes and repeated, if required. Sometimes, it causes severe laryngeal and pulmonary oedema. Vitamin B (hydroxycobalamin) is also used as an antidote. It binds cyanide into nontoxic cyanocobalamin. Aminophenols which produce methaemoglobinaemia faster than nitrites have also been used on experimental basis. Another experimental therapy is the use of stroma free methaemoglobin.

Post-mortem Appearance

The characteristic feature is that the skin presents a livid or violet colour. Post-mortem staining appears as bright red or pink due to cyanomethaemoglobin and also due to the fact that tissues could not take up oxygen from blood leaving bright red colour in veins. The features of asphyxial death are seen. Rigor mortis sets in early and lasts longer. The smell of hydrocyanic acid may be appreciated on opening the body. The blood is bright red in appearance and is fluid. Stomach may show congestion and haemorrhages due to the local action. Mouth and lips may show corrosion.

Medico-legal Significance

Cyanides are widely used for suicidal and homicidal purposes. Accidental poisonings have been reported from the inhalation of vapours of acid used as a fumigating agent. Cyanide is also formed as a result of putrefaction. So, in such cases, quantitative estimation of cyanide is essential to exclude cyanide poisoning. Usually, it is never more than one-tenth the minimum quantity to cause death. Oil of bitter almonds and cherry-laurel water is used as flavouring agents and can cause accidental cyanide poisoning. Cases of cattle poisoning by cyanide have been reported if they eat *Juar Kadvi* as it contains cyanogens.

Some part of hydrocyanic acid is eliminated unchanged through lungs, so in cyanide poisoning it is advised to preserve at least one lung. When potassium cyanide is ingested through mouth, hydrochloric acid present in the stomach is essential for absorption. If a person is suffering from achlorhydria, he may escape poisoning by cyanide. It is said that Rasputin, a Russian doctor who was allegedly having a love affair with Russian Queen was administered cyanide by mouth but he escaped its ill effects as he was suffering from achlorhydria. Nowadays, cyanide capsules are carried by terrorist organisation individuals, who, if caught, commit suicide immediately.

Asphyxiants (Irrespirable Gases)

CARBON DIOXIDE

It is a colourless, odourless gas found in the atmosphere. The concentration of carbon dioxide in atmosphere is 0.04 per cent. Carbon dioxide has a slight acidic taste. When we respire we exude carbon dioxide. It is also formed as a result of putrefaction, fermentation and combustion. It is also found in high concentration in coal mines and lime kilns. It is also found at the bottom of deep wells, damp cellars, mine shafts, ship's holds, etc. The carbon dioxide is also used in refrigeration as dry ice to keep ice creams cooled. It is also used in mineral aerated waters like coke, Pepsi and soda.

Mechanism of Action

When inhaled in dilutions of 5–7 per cent with oxygen, it stimulates the respiratory system. It is a potent vasodilator of cerebral blood vessels. It acts as a corrosive when applied to skin in frozen form (dry ice).

Symptoms

When the air containing 5 per cent of carbon dioxide is inhaled, it causes increased respiration, nausea, acidic taste in mouth, headache, giddiness and loss of muscle power. When a concentration of 10 per cent is reached in the air, it causes hyperpnoea, tinnitus, confusion,

tremors, sweating, visual disturbances and loss of consciousness. If the concentration reaches 25 per cent in the breathed air, it causes convulsions due to direct action on nerves causing cortical excitability. It may lead to death due to asphyxia. If a person inhales carbon dioxide in a concentration of 60–80 per cent, immediate loss of consciousness occurs leading to death. Sub-acute poisoning is seen if the concentration of carbon dioxide increases even up to 0.5 per cent in the air. It is seen in badly ventilated and over crowded rooms. The symptoms include fatigue, headache, mental confusion and irritability. Long term exposure causes anaemia, loss of appetite and fatigue.

Treatment

The person should be immediately removed into open air and artificial respiration should be started with oxygen. Then, an amine buffer can be given intravenously. Artificial respiration should be maintained till the person is stabilised. The vitals should be maintained. The patient should be managed on conservative treatment.

Post-mortem Appearance

The rate of cooling of the body is low and body retains heat for a longer time. Features of asphyxial death are seen.

Medico-legal Significance

Poisoning by carbon dioxide is mainly accidental in workers working in deep bore wells, mine shafts, grain pits and badly ventilated rooms.

CARBON MONOXIDE

Carbon monoxide is a colourless, odourless and tasteless gas. Carbon monoxide poisoning is quite common in India especially during winter when people use *angeethi* in their sleeping rooms. Carbon monoxide poisoning is also very common in the United States and other parts of the world.

Sources of Exposure

Carbon monoxide is formed when there is incomplete combustion of coal due to the lack of oxygen such as in the use of *angeethi*. It is also formed as a result of decomposition of organic substances such as oxalic acids and formic acids. It is also found in the gaseous products from charcoal fires, refineries, blast furnaces, lime kilns, water heaters, gas refrigerators and household fires. It is released in high quantity in a bomb blast. It is a constituent of coal gas. It is present in exhaust of motor vehicles especially those fueled by petrol.

Mechanism of Toxicity

Carbon monoxide combines with haemoglobin with an affinity of 200–250 times that of oxygen, resulting in a decrease in the oxygen carrying capacity of blood. But it is seen that even when haemoglobin levels are down to 40 per cent, the person does not show symptoms of poisoning. Two more mechanisms are involved in poisoning. Carbon monoxide on combining with haemoglobin shifts the oxygen dissociation curve to the left, further reducing the oxygen available to tissues. Also, carbon monoxide is a cellular poison per se as it competes with oxygen for other haemoproteins such as myoglobin, peroxidase, catalases and

cytochromes. Its combination with cytochrome P450 is most important as it disrupts normal cellular metabolism. The transport of carbon monoxide to the cell is through plasma, not through haemoglobin as it does not react to haemoglobin very quickly. That is why, blood carboxyhaemoglobin levels may not be very helpful in assessing the severity of exposure, as it may be normal at the time of the measurement.

Symptoms

The poisoning by carbon monoxide depends on various factors like concentration, duration of exposure and level of activity of the person at that time. The elderly and those suffering from cardio-respiratory diseases are more vulnerable. High humidity, high altitude and high temperatures cause more severe poisoning. When inhaled in dilute form, the usual symptoms are tightness of forehead, dizziness, agitation, confusion, throbbing headache, nausea, noise in the ears, muscular weakness and inability to move. There is a generalized lethargy, ataxia, slurred speech, and drowsiness. The pupils are dilated and fixed, there is dimness of vision, tachypnoea and tachycardia. If carboxyhaemoglobin exceeds 60 per cent, hypotension and a slowing of pulse and respiration is seen. The colour of skin is not reliable to comment on poisoning (Table 40.1).

At low level of exposure, memory, psychomotor and cognitive skills are decreased. Visual acuity is also reduced. Transient deafness, retrobulbar haemorrhages and retinal haemorrhages are reported.

Cerebral oedema, seizures and coma are seen at carboxyhaemoglobin levels of 50 percent. Above level of 70 per cent, survival is not possible. Pulmonary oedema, ECG changes like ST and T changes, atrial fibrillation and conduction defects are seen. Angina and ventricular ectopics can be seen. Intestinal, acute hepatic and muscular necrosis is seen. Even myoglobinuria and myocardial infarction are seen sometimes.

Table 40.1 Poisoning of carbon monoxide

<i>Concentration in atmosphere (%)</i>	<i>Carboxy haemoglobin levels (%)</i>	<i>Clinical symptoms</i>
0.007	10	Dyspnoea on exertion
0.012	20	Headache, dyspnoea, lethargy, nausea
0.022	30	Headache, irritability, nausea, vomiting dizziness, visual acuity affected, fatigability
0.035–0.052	40–50	Headache, confusion, collapse
0.080–0.122	60–70	Coma, convulsions, respiratory failure
0.195	80	Rapid death

Subacute Clinical Features

It occurs within a few days of the exposure. The usual clinical features are peripheral neuropathies, skin lesions like bullae or purpura, muscle and renal damage in addition to above described features. Muscle necrosis can lead to rhabdomyolysis, myoglobinuria and renal damage. Retinal haemorrhages, central hearing loss, cerebellar ataxia, aspiration pneumonia and adult respiratory distress syndrome are also seen.

Delayed Clinical Features

They are usually seen 1–3 weeks after exposure. Headache, nausea, dizziness, aphasia, apraxia, hallucinations, disorientation, bradykinesia, rigidity, gait disturbances and incontinence may be seen. Some persons progress to coma and convulsions. The use of hyperbaric oxygen is helpful in reversing some of the features.

Chronic Poisoning

Due to continuous mild exposure, chronic poisoning may develop. The clinical features are fatigue, headache, nausea, dizziness, difficulty in sleeping, impairment of thinking process, confusion, dyspnoea on exertion, numbness and tingling, chest pain, decreased visual acuity, diarrhoea and abdominal pain.

Intoxication During Pregnancy

If a pregnant mother inhales carbon monoxide the foetus is more affected than the mother. Still births are higher in mothers who are exposed to carbon monoxide. Multiple morphological abnormalities have been reported in live births. Telencephalic dysgenesis of foetus has been seen.

Laboratory Diagnosis

Estimation of carboxyhaemoglobin is a good criteria for assessment of poisoning but in some cases it may be misleading as levels of carboxyhaemoglobin starts falling once the patient has been removed from the site of exposure.

Spot Test

Dilute two drops of blood with 15 ml water and add five drops of 25 per cent sodium hydroxide. The presence of pink colour will confirm carboxyhaemoglobin. Other things that point towards poisoning are metabolic acidosis, ECG changes, hyperglycaemia, raised SGOT and SGPT levels. CT scan of head may show symmetrical and diffuse low density lesions in globus pallidus. These are characteristics of poisoning. The basal ganglia may eventually be calcified.

Treatment

Once the diagnosis is based on the history of exposure and clinical assessment, the treatment

should be started at once. The first step is to remove the person from the site of exposure. Hundred per cent oxygen should be started by mask. Mild poisoning requires oxygen treatment for about 4–6 hours. In severe cases, hyperbaric oxygen should be used. The indications for starting hyperbaric oxygen are any history of loss of consciousness, neurological impairment, carboxyhaemoglobin more than 30–40 per cent, cardiac arrhythmias, syncope or pulmonary oedema. Hyperbaric oxygen is generally used at a pressure of three atmosphere. Hyperbaric oxygen is quite useful in controlling delayed complications. But the side effects of hyperbaric oxygen include barotraumas, ear pain and oxygen toxicity leading to convulsions. Experimental therapy includes the use of allopurinol along with N-acetyl cysteine. Allopurinol retards the production of free radicals while N-acetyl cysteine replenishes the reducing power of cells. If hyperbaric oxygen is not available, use of hypothermia is recommended to reduce metabolic demands.

Post-mortem Appearance

The lips and fingernails show a bright red colour. Irregular patches of bright red colour are seen scattered over anterior surface. The post-mortem staining shows the same bright red colour. The blood in the vessels is seen to be bright red and fluid. The internal organs also appear bright red due to the colour of the blood. The mucous membranes also appear bright red. The lungs are congested and oedematous. The findings suggest asphyxial death. Punctiform haemorrhages and softening in the cerebral cortex and corpus striatum particularly globus pallidus may be seen.

Medico-legal Significance

The carbon monoxide poisoning is mostly accidental. It is commonly seen in north India where people use *angeethi* to warm up their sleeping rooms tightly closed. It is also seen in

workers who work to repair old wells. Accidental poisoning also occurs in motor garages, overcrowded rooms, ill-ventilated rooms. Suicidal poisoning is reported where a person trying to commit suicide shuts himself in a car and puts pipe from exhaust into the car and closes the car doors. Homicidal use of carbon monoxide is reported, but quite rarely. Putrefaction has no effect on carboxyhaemoglobin, therefore its levels can be estimated even several days after death.

WAR GASES

It denotes chemical warfare. The term “gas” used in such context denotes a chemical compound whether gas, liquid or solid which is employed to produce poisonous or irritant effect on enemy forces or civil population. The following are the common compounds used in chemical warfare:

1. **Vesicating Agents:** The common vesicating or blistering agents are mustard gas (dichlorodiethyl chloride) and lewisite (chlorovinyl dichloramine). Mustard gas was widely used in world wars. It causes irritation in the eyes, lacrimation, nasal secretion, laryngitis and severe gastric pain. It affects skin locally and causes itching, redness, vesication and ulceration. Axilla, groin and perineum are severely affected. Death occurs due to infections. Lewisite is a vesicant and asphyxiant. It is more severe in action as compared to mustard gas. It affects in the same manner as mustard gas.
2. **Asphyxiants:** The common asphyxiants used are chlorine, phosgene (carbonyl chloride), diphosgene, and chloropicrin. Phosgene is one of the most poisonous gases known to mankind. They cause intense respiratory discomfort by irritation, and cause death by asphyxia.
3. **Tear Gases:** 1-chloro-acetophenone (CAP or CN) and bromobenzyl cyanide (BBC.) are mainly used as tear gases. These gases are widely used all over the world for riot

control by police. They cause severe irritation in the eyes leading to flow of tears, spasm of eyelids and even temporary blindness. It can also cause some respiratory discomfort. The treatment includes washing eyes with water.

4. **Nasal Irritants:** These are organic compounds of arsenic which are converted to gaseous form when heated, and can cause

nasal irritation. They cause intense pain in nose, sneezing, headache, salivation, vomiting and temporary prostration.

5. **Paralysants:** These are mainly hydrocyanic acid and sulphuretted hydrogen. They are not used at mass level.
6. **Nerve Gases:** They are usually related to phosphate esters and produce vapours. The exact formulae are not known.

Food Poisoning

The term food poisoning denotes any illness that occurs after eating or drinking some food material. It may be of the following types:

1. Bacterial
2. Food poisoning because of poisonous plants like mushrooms
3. Food poisoning through animals like poisonous fish
4. Chemical food poisoning when some chemicals are added into the food material.

BACTERIAL FOOD POISONING

It is the most common type of food poisoning. It is usually caused by the following organisms:

1. ***Staphylococcus***: This is the most common bacterial food poisoning. It usually starts within 1–8 hours after consumption of milk, milk products, meat, etc. The usual clinical feature is intense vomiting. The onset is sudden. Usually, recovery is seen in a day. Most of the time, no treatment is required except electrolytes to correct dehydration.
2. ***Bacillus cereus***: This poisoning is characterised by primary symptoms of diarrhoea and vomiting. The incubation period varies from 3–16 hours. There are two types of toxins present in this poisoning. One is heat labile and the other is heat stable. This

poisoning occurs through contaminated food like fried rice, dried fruit and powdered milk. The treatment is mainly symptomatic and supplement of electrolytes is required.

3. ***Clostridium botulinum***: This is one of the most lethal poisoning. It was first reported following ingestion of uncooked sausages, thus deriving the name from ‘botulismus’ meaning sausage. The clostridium bacteria generates a toxin which blocks acetylcholine at the neuromuscular junction producing a bilaterally symmetrical descending motor paralysis (bulbar paralysis). The incubation period may vary from a few hours to a week. The other symptoms include diplopia, dysphagia, dry mouth, dysphonia, dysarthria and pulmonary depression. The treatment includes intense supportive treatment and use of antitoxin.
4. ***Shigella***: The main clinical features are the abrupt onset of diarrhoea, sometimes bloody, and pus in stools. The incubation period is 1–3 days. The symptoms are due to enterotoxin and neurotoxin. The treatment includes use of antibiotics, and supportive treatment is required.
5. ***Salmonella***: This infection is also quite common and presents as typhoid, which is characterised by high grade fever, headache and myalgia. It is mainly due to the ingestion

of contaminated food like eggs, milk and meat. The initial symptoms may include watery diarrhoea stained with blood or mucus. The incubation period is 12–18 hours. The treatment includes use of antibiotics mainly chloramphenicol along with supportive treatment.

6. ***Vibrio cholerae***: This commonly manifests as explosive watery diarrhoea. It is a mainly water borne illness caused by drinking contaminated water, *lassi* or cold drink. The incubation period is 1–3 days. It is due to enterotoxin produced by the bacteria. Treatment includes immediate replacement of electrolytes and use of antibiotics. This poisoning is quite common in big fairs.
7. ***E. coli***: Normally, it is a part of flora of the intestine but sometimes it causes diarrhoea. The incubation period is 1–3 days.
8. ***Campylobacter***: This organism usually grows in jejunum and is the most common cause of diarrhoea worldwide. The infection is due to ingestion of contaminated water, milk or meat. The clinical symptoms include watery or bloody diarrhoea along with fever. The disease is usually a self-limiting one.
9. ***Traveller's diarrhoea***: It is seen among travellers. When a person visits another place, he suffers from abdominal discomfort, diarrhoea, fever and sometimes vomiting. The illness is self-limiting.

Post-mortem Findings

In most cases of bacterial food poisoning, the main feature is congestion present in the stomach and intestines. Ulceration may be seen.

Medico-legal Significance

Most of the bacterial food poisoning is accidental due to ingestion of contaminated food. Mass food poisoning cases are reported after ingestion of *prasad* in temples, or in weddings or in big fairs.

POISONOUS FOOD

Eating poisonous food also causes ill-effect. The common poisonous foods are:

1. ***Lathyrus sativus***: It is commonly called *khesari dal* and is a staple food among lower income groups in Madhya Pradesh, Chattisgarh and adjoining areas. The active neurotoxin is BOAA (B-N-Oxaly aminoalanine) which is present in *khesari dal*. The clinical features are caused when consumption of *dal* exceeds 30 per cent of the total diet. The symptoms are spastic paralysis of lower limbs due to affection of pyramidal tracts by the toxin. In mild poisoning cases, there may be only mild muscular weakness in legs. The significant post-mortem finding is sclerosis of the lateral columns.
2. ***Argemone mexicana***: The common names are prickly poppy, or *pila dhatura*. This plant grows wildly all over India. The plant has spiny leaves, yellow flowers and prickly capsules containing small black seeds. These seeds resemble mustard seeds. Oil is extracted from these seeds and is used to adulterate mustard oil. The consumption of this oil can cause dropsy. The active principles in argemone oil are sanguinarine and dihydro sanguinarine. There have been many episodes of epidemic dropsy reported from various parts of India in the recent past. The clinical features of dropsy are vomiting, diarrhoea, pedal oedema, generalised anasarca, pleural effusion, pericardial effusion, hepatomegaly and congestive heart failure. Death may be caused due to myocardial damage. Breathlessness may be seen in some cases.
Treatment is mainly supportive. Diuretics and steroids are used.

MUSHROOM POISONING

There are about 5,000 species of mushrooms. But only 50–100 are poisonous. Majority of the poisoning occurs due to ingestion of *Amanita phalloides*.

Structure of a Mushroom

A mushroom is made up of a cap, a stem, gills and spores which are on the gills. The vulva is the partial remnant of the veil found around the base of the stem in some species. The veil is a membrane that sometimes completely or partially covers the gills. The annulus is a ring-like structure that may surround the stem and is a remnant of the partial veil.

Clinical Features

Poisoning by mushroom is of the following two types:

1. Short Incubation Poisoning

It may be classified according to the species causing it:

- (a) **Omphalotus species:** Muscurine is the toxin contained in this group. It acts rapidly and affects autonomic system. The cholinergic symptoms like sweating, lacrimation, miosis, blurred vision, diarrhoea, abdominal cramps and bradycardia are reported. The symptoms appear in about 60 minutes and go within 24 hours. The treatment is supportive. Atropine may be given only in cases of severe poisoning.
- (b) **Coprinus groups:** This variety has a toxin called coprine and it inactivates the enzyme acetaldehyde dehydrogenase. It also produces autonomic features. It acts as an Antabuse and it produces side effects if alcohol is taken along with mushroom. The symptoms include

nausea, vomiting, hypotension and paraesthesias. The treatment is supportive. Recovery occurs in 2–4 hours. Alcohol should be avoided.

2. Long Incubation Poisoning

In this poisoning, the symptoms are produced only after 6–24 hours and include following variety of mushrooms:

- (a) **Gyromitra group:** It contains a toxin named monomethyl hydrazine. The clinical features are nausea and vomiting followed by muscle cramps, severe abdominal pain with severe diarrhoea. Diarrhoea may sometimes be bloody. Fever, liver failure, along with convulsions, coma and death may be seen in severe poisoning. The treatment is supportive and includes high dose of pyridoxine.
- (b) **Amanita phalloides and Galerina group:** This group contributes up to 95 per cent of mushroom fatalities. Amatoxin and phallotoxin are the toxins present in mushrooms. They are thermostable. The main site of action is gastrointestinal tract, liver and renal tubules. Phallotoxin acts rapidly and affects gastrointestinal tract while amatoxin acts later (18–24 hours). There are three stages in the poisoning by *A. phalloides*.

Stage I: Vomiting, profuse watery diarrhoea with severe abdominal pains. This stage lasts for 24–36 hours. Severe dehydration and electrolyte loss may be seen.

Stage II: Severe liver and renal damage is seen. It lasts for 12–24 hours.

Stage III: Acute renal failure with hepatic necrosis causing hypoglycaemia, septic infection and death. If a pregnant woman takes *A. phalloides*, the child is not affected as amatoxin does not cross placental barrier.

Amanita muscaria

It contains a toxin called ibotenic acid which acts very fast. The symptoms include dizziness, ataxia, muscle twitching and rarely hallucinations. The mushroom contains small amount of muscarine. The treatment is mainly supportive.

Psilocybe Groups: The toxin has a structure like LSD. The clinical features are very rapid and include mood elevation and hallucinations. Symptoms remain for 6–10 hours. The treatment is mainly supportive.

Treatment

Gastric lavage is quite useful even lately as toxins are still found in duodenal aspirate even after a long time. Charcoal may be given later or after gastric lavage. In early admission, forced diuresis is very helpful. Some scientists have used thioctic acid with glucose solution with some success. Others doubt this. Plasma exchange is useful. Charcoal

haemoperfusion is helpful. Rest of the treatment is supportive. Since toxins are secreted in breast milk, mothers should not be allowed to feed babies during treatment.

Medico-legal Significance

Mushroom poisoning is mostly accidental as there may be mixing of poisonous mushroom in the edible ones. The poisonous mushroom should be identified. The typical *Amanita phalloides* mushroom, also called ‘death cap’ has an olive green cap, white gills, a skirt-like ring on the stipe and a vulva. It should be distinguished by common edible variety of *Amanita* which is large, with an orange cap that is partially covered with a patch on top. Cases have been reported where mushrooms have been used as homicidal poisons too as *A. phalloides* has pleasant taste. It is a common belief that poisons are removed if mushrooms are boiled but this is not true. Poisonous mushrooms are rarely used for suicidal purposes.





APPENDICES





APPENDIX

1

Common Features of Some Toxic Agents

Table 1 Fatal doses and fatal periods of common toxic agents

	<i>Poison</i>	<i>Fatal dose</i>	<i>Fatal period</i>
1.	Aspirin (acetyl salicylic acid)	20–30 gm	Few minutes to few hours
2.	Acid (minerals like sulphuric acid)	10–15 ml	18–24 hours
3.	Aconite root	2 gm	Few hours – 1 day
4.	Aluminum phosphide (celphos)	1 tablet or 3 gm	30 minutes – few hours
5.	Arsenic trioxide	250 gm	12–48 hours
6.	Atropine	10 mg	3–6 hours
7.	Long acting barbiturates	6–10 gm	Few hours
8.	Short acting barbiturates	1–2 gm	2–3 minutes
9.	Phenol (carbolic acid)	20 ml	3–4 hours
10.	Castor seeds (crushed)	5–10 seeds	1–2 days
11.	Cocaine	1–2 gm	5–30 minutes
12.	Copper sulphate	30 gm	1–2 days
13.	Curare	60 mg	Few hours
14.	Cyanide	50–200 mg	2–10 minutes
15.	Dhatura	50–75 seeds	24 hours
16.	DDT	15–30 gm	Few hours
17.	Diazinon	1 gm	Few hours
18.	Ethyl alcohol	600–750 ml	12–24 hours
19.	Ethylene glycol	100 ml	Few hours
20.	Formaldehyde	30–60 ml	Few hours
21.	Heroin	50 mg	Few minutes–30 minutes
22.	Iron	200 mg/kg	24–30 hours
23.	Isopropanol	200–250 ml	Variable on dose
24.	Lead acetate	10 gm	2–3 days
25.	Malathion	1 gm	Few hours
26.	Mercuric chloride	1–2 gm	3–5 days
27.	Methyl alcohol	70–100 ml	24–36 hours
28.	Morphine	200 mg	8–12 hours

Contd.

Contd. Table 1

	Poison	Fatal dose	Fatal period
29.	Nicotine	200 mg	10–15 minutes
30.	Oleander	5–15 leaves or 15 gm root	Few hours–one day
31.	Opium	500 mg	Few hours
32.	Organochloro compounds	2–6 gm	4–6 hours
33.	Oxalic acid	15–20 gm	Variable
34.	Paracetamol	12–20 gm	Variable 12 hours–4 days
35.	Parathion	100 mg	Few hours
36.	White phosphorous	60–120 mg	4–40 hours
37.	Red phosphorous	Non-toxic	Not applicable
38.	Strychnine (one crushed seed)	50–100 mg	1–2 hour
39.	Thallium salt	1 gm	24–30 hours
40.	Croton seed	1 seed	12–24 hours
41.	Marking nut (<i>Semecarpus anacardium</i>)	5 gm	12–24 hours
42.	Cantharides	1–2 gm	24–36 hours
43.	Snakes		
	Cobra	12 mg	Few minutes
	Russell's viper	15 mg	Few hours – few days
	Krait	6 mg	Few hours – few days
	<i>Echis carinatus</i>	3 mg	Few hours – few days
44.	Powdered glass	Uncertain	Uncertain
45.	Diamond powder	Non-toxic	Not applicable
46.	Diazepam (benzodiazepines)	Non-toxic	Not applicable
47.	Cannabis	No fatality	Not applicable
48.	Digitalis	2–3 gm	Few hours – one day
49.	Carbon monoxide	80 per cent in air	Rapid death
50.	Carbon dioxide	60–80 per cent in air	Rapid death
51.	Mushroom	Variable depending on variety	Variable

Table 2 Preferred solutions for gastric lavage for common poisons

	Poison	Preferred solution for gastric lavage
1.	Unknown poisoning or any poisoning if other solutions are not available	Plain water or saline
2.	Cyanides	Sodium thiosulphate (25 per cent concentration)
3.	Phenol (carbolic acid)	Castor oil with warm water (1:2)
4.	Iron	Desferrioxamine (2 gm in a litre of water)
5.	Oxalates	Calcium gluconate
6.	Alkaloids and salicylates	Potassium permanganate (1:5000)

Table 3 Eye changes due to different poisons

	<i>Eye change</i>	<i>Poisons</i>
1.	Nystagmus	Alcohol, barbiturates, phencyclidine, phenytoin, carbamazepine
2.	Mydriasis (dilatation of pupil)	Alcohol, amphetamines, carbon monoxide, anti-histaminic, cocaine, dhatura, ephedrine, atropine
3.	Miosis (constriction of pupils)	Morphine and other opiates, barbiturates, benzodiazepines, caffeine, carbamates, phenol, nicotine, organophosphates, clonidine

Relevant Sections of Law for Medical Practice

INDIAN EVIDENCE ACT (ACT OF 1872)

Sec. 113A: Presumption as to abetment of suicide by a married woman—When the question is whether the commission of suicide by a woman has been abetted by her husband or any relative of her husband and it is shown that she had committed suicide within a period of seven years from the date of her marriage, and that her husband or such relative of her husband had subjected her to cruelty, the Court may presume, having regard to all the other circumstances of the case, that such suicide had been abetted by her husband or by such relative of her husband.

Explanation: For the purpose of this section, ‘cruelty’, shall have the same meaning as in Sec. 498A of the Indian Penal Code (45 of 1860).

Sec. 114A: Presumption as to absence of consent in certain prosecutions for rape—In a prosecution for rape under C1 (a) or C1 (b) or C1 (c) or C1 (d) or C1 (e) or C1 (g) of subsection (2) of Sec. 376 of the Indian Penal Code (45 of 1860), where sexual intercourse by the accused is proved and the question is whether it was without the consent of the woman alleged to have been raped and she states in her evidence before the Court that she did not consent, the Court shall presume that she did not consent.

THE CODE OF CRIMINAL PROCEDURE, 1973

Sec. 53: Examination of the accused by medical practitioner at the request of police officer—

1. When a person is arrested on a charge of committing an offence of a nature and alleged to have been committed under such circumstances that there are reasonable grounds for believing that an examination of this person will afford evidence as to the commission of an offence, it shall be lawful for a registered medical practitioner acting at the request of a Police Officer not below the rank of Sub-Inspector and for any person acting in good faith in his aid and under his direction to make such an examination of the person arrested as is reasonably necessary in order to ascertain the facts which may afford such evidence and to use such force as is reasonably necessary for that purpose.
2. Whenever the person of a female is to be examined under this section, the examination shall be made only by or under the supervision of a female registered Medical Practitioner.

Sec. 54: Examination of arrested person by Medical Practitioner at the request of arrested person—When a person who is arrested, whether on a charge or otherwise, alleges at the time when he is produced before a Magistrate or at any time during the period of his detention in custody that the examination of his body will afford evidence which will disprove the commission by him of any offence or which will establish the commission by any other person of any offence against his body. The Magistrate shall, if requested by the arrested person to do so, direct the examination of the body of such person by a registered Medical Practitioner unless the Magistrate considers that the request is made for the purpose of vexation of delay or for defeating the end of justice.

THE POWERS OF POLICE TO INVESTIGATE

Sec. 154: Information in cognisable cases—

1. Every information relating to the commission of a cognisable offence, if given orally to an officer in charge of a police station, shall be reduced to writing by him or under his direction, and be read over to the informant; and every such information, whether given in writing or reduced to writing as aforesaid shall be signed by the person giving it and the substance thereof shall be entered in a book to be kept by such officer in such form as the State Government may prescribe in this behalf.

Sec. 174: Police to inquire and report on suicide, etc.—

1. When the officer in charge of a police station, or some other police officer, specially empowered by the State Government in that behalf, receives information that a person has committed suicide, or has been killed by another or by an animal, or by machinery, or by an accident, or has died in circumstances raising a reasonable suspicion that some other person has committed an offence, he shall

immediately give intimation thereof to the nearest Executive Magistrate empowered to hold inquests, and unless otherwise directed by any rule prescribed by the State Government or by any general or special order of the district or Sub-Divisional Magistrate, shall proceed to the place where the body of such deceased person is, and there in the presence of two or more respectable inhabitants of the neighbourhood, shall make an investigation and draw up a report of the apparent cause of death, describing such wounds, fractures, bruises and other marks of injury as may be found on the body and stating in what manner, or by what weapon or instrument (if any) such marks appear to have been inflicted.

2. The report shall be signed by such police officer and other persons, or by so many of them, as concur herein, and shall be forthwith forwarded to the District Magistrate or the Sub-Divisional Magistrate.
3. When there is any doubt regarding the cause of death, or when for any other reason the police-officer considers it expedient to do so, he shall, subject to such rules as the State Government may prescribe in this behalf, forward the body, with a view to its being examined to the nearest Civil Surgeon or other qualified medical man appointed in this behalf by the State Government, if the state of the weather and the distance admit of its being so forwarded without risk of such putrefaction on road as would render such examination useless.
4. The following Magistrates are empowered to hold inquests, namely, any District Magistrate, Sub-Divisional Magistrate, or any other Executive Magistrate specially empowered in this behalf by the State Government or the District Magistrate.

Amendment of Section 174—In the Code of Criminal Procedure, 1973 (hereinafter referred to

as the Code of Criminal Procedure) in Section 174, in sub-section (3), for the words “When there is any doubt regarding the cause of death, or when for any other reason the police officer considers it expedient so to do, he shall,” the following shall be substituted, namely “When—(i) the case involves suicide by a woman within seven years of her marriage; or (ii) the case relates to the death of a woman within seven years of her marriage in any circumstances raising a reasonable suspicion that some other person committed an offence in relation to such woman; or (iii) the case relates to the death of a woman within seven years of her marriage and any relative of the woman has made a request in this behalf; or (iv) there is any doubt regarding the cause of death; or (v) the police officer for any other reason consider expedient so to do, he shall.”

Sec. 175: Power to summon persons—

1. A police officer proceeding under Section 174 by order in writing, summons two or more persons as aforesaid for the purpose of the said investigation and any other person who appears to be acquainted with the facts of the case. Every person so summoned shall be bound to attend and to answer truly all questions other than questions the answer to which would have a tendency to expose him to a criminal charge, or to a penalty or forfeiture.
2. If the facts do not disclose a cognisable offence to which Section 170 applies, such persons shall not be required by the police officer to attend a Magistrate Court.

Sec. 176: Inquiry by Magistrate into the cause of death—

1. When any person dies while in the custody of the police, the nearest Magistrate empowered to hold inquests shall, and in any other case mentioned in sub-section (1) of Section 174 any Magistrate so empowered may, hold an inquiry into a cause of death either instead of, or in addition to the investigation held by the

police officer, and if he does so, he shall have all the powers in conducting it which he would have in holding an inquiry into an offence.

2. The Magistrate holding such an inquiry shall record the evidence taken by him in connection herewith in any of the manners hereinafter prescribed according to the circumstances of the case.
3. Power to disinter corpses—whenever such Magistrate considers it expedient to make an examination of the dead body of any person who has already been interred in order to discover the cause of his death, the magistrate may cause the body to be disinterred and examined.
4. When an enquiry is to be held under this section, the Magistrate shall, wherever possible, inform the relatives of the deceased whose names and addresses are known and shall allow them to remain present at the enquiry (Explanation—relatives mean, parents, children, brothers, sisters and spouse).

Amendment of Section 175— In Section 176 of the Code of Criminal Procedure, in sub-section (1) for the words “When any person dies while in the custody of the police” the words, brackets and figures ‘when any person dies while in the custody of the police or when the case is of the nature referred to in clause (i) or clause (ii) of sub-section (8) of Section 174’ shall be substituted.

Sec. 198(6): Prosecution of offence for marital misbehaviour— No Court shall take cognisance of an offence under Section 376 of the Indian Penal Code, where such offence consists of sexual intercourse by a man with his own wife, the wife being under fifteen years of age, if more than one year has elapsed from the date of the commission of the offence.

Sec. 291: Deposition of medical witness—

1. The deposition of a Civil Surgeon or other medical witness, taken and attested by a

Magistrate in the presence of the accused, or taken on commission under this chapter, may be given in evidence in any inquiry, trial or other proceedings under this Code, although the deponent is not called a witness.

2. The Court may, if it thinks fit, and shall on the application of the prosecution of the accused, summon and examine any such deponent as to the subject matter of his deposition.

Sec. 293. Reports of certain government scientific experts—

1. Any document purporting to be a report under the hand of a government scientific expert to whom this section applies, upon any matter or thing duly submitted to him for examination or analysis and report in the course of any proceeding under this Code, may be used as evidence in any inquiry, trial or other proceedings under this Code.
2. The Court may, if it thinks fit, summon and examine any such expert as to the subject matter of his report.
3. Where any such expert is summoned by a Court and he is unable to attend personally, he may, unless the Court has expressly directed him to appear personally, depute any responsible officer working with him to attend the Court, if such officer is conversant with the facts of the case and can satisfactorily depose in Court on his behalf.
4. This section applies to the following Government scientific experts, namely:
 - a. Any Chemical Examiner or Assistant Chemical Examiner to Government.
 - b. The Chief Inspector of Explosives;
 - c. The Director of the Finger Print Bureau;
 - d. The Director, Haffkine Institute, Bombay;
 - e. The Director*(Deputy Director or Assistant Director) of a Central Forensic Science Laboratory or a State Forensic Science Laboratory;

f. The Serologist to the Government.

Amendment of Section 327—

1. In the Code of Criminal Procedure, 1973 (hereinafter referred to as the Criminal Procedure Code), Section 327 shall be renumbered as sub-section (1) of that section and after it, as so renumbered, the following sub-sections shall be inserted, namely—
2. “Notwithstanding anything contained in sub-section (1), the inquiry into the trial of rape or an offence under Section 376, Section 376A, Section 376B, Section 376C or Section 376D of the Indian Penal Code shall be conducted in camera:
Provided that the presiding judge may, if he thinks fit, or on an application made by either of the parties, allow any particular person to have access to, or remain in the room or building used by the court.
3. Where any proceedings are held under sub-section (2), it shall not be lawful for any person to print or publish any matter in relation to any such proceedings, except with the previous permission of the court”.

Sec. 366(1): Sentence of death to be submitted by Court of Session for confirmation— When the Court of Session passes sentence of death, the proceedings shall be submitted to the High Court, and the sentence shall not be executed unless it is confirmed by the High Court.

Sec. 416(1): Postponement of capital sentence on pregnant woman— If a woman sentenced to death is found to be pregnant, the High Court shall order the execution of the sentence to be postponed and may, if it thinks fit, commute the sentence to transportation for life.

THE INDIAN PENAL CODE

34. *Act done by several persons in furtherance of common intention—* When a criminal act is done by several persons, in furtherance

- of the common intention of all, each of such person is liable for that act in the same manner, as if it were done by him alone.
44. *Injury*—The word “injury” denotes any harm whatever illegally caused to any person in body, mind, reputation, or property.
51. *Oath*—The word “oath” includes a solemn affirmation substituted by law for an oath, and declaration required or authorised by law to be made before a public servant or to be used for the purpose of proof, whether in a Court of Justice or not.
52. *Good faith*—Nothing is said to be done or believed in good faith which is done or believed without due care and attention.
53. *Punishments*—The punishments to which offenders are liable under the provisions of this Code are:
Firstly—Death; *Secondly*—Imprisonment for life; *Thirdly*—Imprisonment, which is of two descriptions, namely: (1) Rigorous, that is, with hard labour, (2) Simple; *Fourthly*—Forfeiture of property; *Fifthly*—Fine; *Sixthly*— Detention in reformatories.
80. *Accident in doing a lawful act*—Nothing is an offence which is done by accident or misfortune, and without any criminal intention or knowledge in the doing of a lawful act in the lawful manner by a lawful means and with proper care and caution.
81. *Act likely to cause harm, but done without criminal intent, and to prevent other harm*—Nothing is an offence merely by reason of its being done with the knowledge that it is likely to cause harm, if it be done without any criminal intention to cause harm, and good faith for the purpose of preventing or avoiding other harm to person or property.
Explanation: It is a question of fact in such a case whether the harm to be prevented or avoided was of such a nature and so imminent as to justify or excuse the risk or doing the act with the knowledge that it was likely to cause harm.
82. *Act of a child under seven years of age*—Nothing is an offence which is done by a child under seven years of age.
83. *Act of a child above seven and under twelve of immature understanding*—Nothing is an offence which is done by a child above seven years of age and under twelve, who has not attained sufficient maturity of understanding to judge the nature and consequences of his conduct on that occasion.
84. *Act of a person of unsound mind*—Nothing is an offence which is done by a person who, at the time of doing it, by reason of unsoundness of mind, is incapable of knowing the nature of the act, or that he is doing what is either wrong or contrary to law.
85. *Act of a person incapable of judgement by reason of intoxication caused against his will*—Nothing is an offence which is done by a person who, at the time of doing it, is by reason of intoxication, incapable of knowing the nature of the act, or that he is doing what is either wrong or contrary to law provided that the thing which intoxicated him was administered to him without his knowledge or against his will.
86. *Offence requiring a particular intent or knowledge committed by one who is intoxicated*—In cases where an act done is not an offence unless done with a particular knowledge or intent, a person who does that act in a state of intoxication shall be liable to be dealt with as if he had the same knowledge as he would have had if he had not been intoxicated, unless the thing which intoxicated him was administered to him without his knowledge or against his will.
87. *Act not intended and not known to be likely to cause death or grievous hurt, done by consent*—Nothing which is not intended to cause death, or grievous hurt, and which is not known by the doer to be likely to cause death or grievous hurt, is an offence by

reason of any harm which it may cause, or be intended by the doer to cause, to any person, above eighteen years of age, who has given consent, whether expressed or implied, to suffer that harm; or by reason of any harm which it may be known by the doer to be likely to cause to any such person who has consented to take the risk of that harm.

88. *Act not intended to cause death, done by consent in good faith for person's benefit*—Nothing, which is not intended to cause death, is an offence by reason of any harm which it may cause, or be intended by the order to cause, or known by the order to be likely to cause, to any person for whose benefit it is done in good faith, and who has given consent, whether expressed or implied, to suffer that harm, or to take the risk of that harm.

89. *Act done in good faith for the benefit of child or insane person, by or by consent of guardian*—Nothing which is done in good faith for the benefit of a person under twelve years of age, or of unsound mind, by or by consent, either expressed or implied, of the guardian or other person having lawful charge of that person, is an offence by reason of any harm which it may cause, or be intended by the doer to cause, or be known by the doer to be likely to cause, to that person:

Provided: *Firstly*—That this exception shall not extend to the intentional causing of death, or to the attempting to cause death; *Secondly*— That this exception shall not extend to the doing of anything which the person doing it knows to be likely to cause death, for any purpose other than the preventing of death or grievous hurt or the curing of any grievous disease of infirmity; *Thirdly*—That this exception shall not extend to the voluntary causing of grievous hurt, or to the attempting to cause grievous hurt or the curing of any grievous disease

or infirmity; *Fourthly*—that this exception shall not extend to the abetment of any offence, to the committing of which offence it would not extend.

90. *Consent known to be given under fear or misconception*—A consent is not such a consent as is intended by any section of this Code, if the consent is given by a person under fear of injury, or under a misconception of fact, and if the person doing the act knows, or has reason to believe, that the consent was given in consequence of such fear or misconception; or if the consent given by a person who, from unsoundness of mind or intoxication, is unable to understand the nature and consequence of that to which he gives his consent; or unless the contrary appears from the context, if the consent is given by a person who is under twelve years of age.
91. *Exclusion of acts which are offences independently of harm caused*—The exceptions in Sections 87, 88 and 89 do not extend to acts which are offences independently of any harm which they may cause or be intended to cause, or known to be likely to cause, to the person giving the consent or on whose behalf the consent is given.
92. *Act done in good faith for the benefit of a person without consent*—Nothing is an offence by reason of any harm which it may cause to a person for whose benefit it is done in good faith, even without that person's consent, if the circumstances are such that it is impossible for that person to signify consent or if that person is incapable of giving consent, and has no guardian or other person in lawful charge of him from whom it is possible to obtain consent in time for the thing to be done with benefit: Provided: *Firstly*—That this exception shall not extend to the intentional causing of death or the attempting to cause death; *Secondly*—That

this exception, shall not extend to the doing of any thing which the person doing it knows to be likely to cause death for any purpose other than the preventing of death or grievous hurt or the curing of any grievous disease or infirmity; *Thirdly*—That this exception shall not extend to the voluntary causing of hurt, or the attempting to cause hurt, for any purpose other than the preventing of death or hurt; *Fourthly*—That this exception shall not extend to the abetment of any offence, to the committing of which offence it would not extend.

197. *Issuing or signing false certificate*—

Whoever issues or signs any certificate required by law to be given or signed, or relating to any fact of which such certificate is by law admissible in evidence, knowing or believing that such certificate is false in any material point, shall be punished in the same manner as if he gave false evidence.

228A. *Disclosure of Identity of the victim of certain offences, etc.*—

1. Whoever prints or publishes the name or any matter which may make known the identity of any person against whom an offence under Section 376, Section 376A, Section 376B, Section 376C or Section 376D is alleged or found to have been committed (hereafter in this section referred to as the victim) shall be punished with imprisonment of either description for a term which may extend to two years and shall also be liable to fine.
2. Nothing in sub-section (1) extends to any printing or publication of the name or any matter which may make known the identity of the victim if such printing or publication is— (a) by or under the order in writing of the officer-in-charge of the police station or the police officer making the investigation into such offence acting in good faith for the

purposes of such investigation; or (b) by or with the authorisation in writing of the victim, or (c) where the victim is dead or minor or of unsound mind, by or with the authorisation in writing of the next of kin of the victim:

Provided that no such authorisation shall be given by the next of kin to anybody other than the chairman or the secretary, by whatever name called, of any recognised welfare institution or organisation.

Explanation—For the purposes of this subsection, “recognised welfare institution or organisation” means a social welfare institution or organisation recognised in this behalf by the Central or State Government.

3. Whoever prints or publishes any matter in relation to any proceeding before a court with respect to an offence referred to in subsection (i) without the previous permission of such court shall be punished with imprisonment of either description for a term which may extend to two years and shall also be liable to fine.

Explanation—The printing or publication of the judgement of any High Court or the Supreme Court does not amount to an offence within the meaning of this section.

284. *Negligent conduct with respect to poisonous substance*—Whoever does, with any poisonous substance, any act in a manner so rash or negligent as to endanger human life, or to be likely to cause hurt or injury to any person, or knowingly or negligently omits to take such order, with any poisonous substance in his possession as is sufficient to guard against probable danger to human life from such poisonous substance shall be punished with imprisonment of either description for a term which may extend to six months, or with fine which may extend to one thousand rupees, or with both.

299. *Culpable homicide*—Whoever causes death by doing an act with the intention of causing

such bodily injury as is likely to cause death, or with the knowledge that he is likely by such act to cause death, commits the offence of culpable homicide.

Explanation. 1—A person who causes injury to another who is labouring under a disorder, disease or bodily infirmity, and thereby accelerates the death of the other, shall be deemed to have caused this death.

Explanation. 2—Where death is caused by bodily injury, the person who causes such bodily injury shall be deemed to have caused the death, although by resorting to proper remedies and skilful treatment the death might have been prevented.

Explanation. 3—The causing of the death of child in the mother's womb is not homicide. But it may amount to culpable homicide to cause the death of a living child, if any part of that child has been brought forth, the child may not have breathed or been completely born.

300. *Murder*—Except in the cases hereinafter excepted, culpable homicide is murder, if the act by which the death is caused is done with the intention of causing death, or

Secondly—If it is done with the intention of causing such bodily injury as the offender knows to be likely to cause the death of the person; to whom the harm is caused, or

Thirdly—If it is done with the intention of causing bodily injury to any person and the bodily injuries intended to be inflicted is sufficient in the ordinary course of nature to cause death, or

Fourthly—If the person committing the act knows that it is so imminently dangerous that it must in all probability cause death or such bodily injury as is likely to cause death and commits such act without any excuse for incurring the risk of causing death or such injury as aforesaid.

Exception 1—Culpable homicide is not murder if the offender whilst deprived of the power of self-control by grave and sudden provocation, causes the death of the person who gave the provocation or causes the death of other person by mistake or accident.

The above exception is subject to the following provisos:

Firstly—That the provocation is not sought or voluntarily provoked by the offender as an excuse for killing or doing harm to any person.

Secondly—That the provocation is not given by anything done in obedience to the law or by a public servant in the lawful exercise of the powers of such public servant.

Thirdly—That the provocation is not given by anything in the lawful exercise of the right of private defence.

Explanation 1—Whether the provocation was grave and sudden enough to prevent the offence from amounting to murder is a question of fact.

Exception 2—Culpable homicide is not murder if the offender in the exercise in good faith of the right of private defence of person or property, exceeds the power given to him by law and causes the death of the person against whom he is exercising such right of defence without premeditation, and without any intention of doing more harm than is necessary for the purpose of such defence.

Exception 3—Culpable homicide is not murder if the offender, being a public servant or aiding a public servant acting for the advancement of public justice, exceeds the powers given to him by law, and causes death by doing an act which he, in good faith, believes to be lawful and necessary for the due discharge of his duty as such public servant and without ill-will towards the person whose death is caused.

Exception 4—Culpable homicide is not murder if it is committed without premeditation in a sudden fight in the heat of passion upon a sudden quarrel and without the offender's having taken undue advantage or acted in a cruel or unusual manner.

Explanation—It is immaterial in such cases which party offers the provocation or commits the first assault.

Exception 5—Culpable homicide is not murder when the person whose death is caused, being above the age of eighteen years, suffers death or takes the risk of death with his own consent.

301. *Culpable homicide by causing death of person other than person whose death was intended*—If a person, by doing anything which he intends or knows to be likely to cause death, commits culpable homicide by causing the death of any person, whose death he neither intends nor knows himself to be likely to cause, the culpable homicide committed by the offender is of the description of which it would have been if he had caused the death of the person whose death he intended or knew himself to be likely to cause.
302. *Punishment for murder*—Whoever commits murder shall be punished with death, or transportation for life, and shall also be liable to fine.
303. *Punishment for murder by life convict*—Whoever, being under sentence of transportation for life, commits murder, shall be punished with death.
304. *Punishment for culpable homicide not amounting to murder*—Whoever commits culpable homicide not amounting to murder, shall be punished with imprisonment for life, or imprisonment of either description for a term which may extend to ten years, and shall also be liable to fine if the act by which the death is caused is done with the intention of causing death, or of causing such bodily injury as is likely to cause death; or with imprisonment of either description for a term which may extend to ten years, or with fine, or with both, if the act is done with the knowledge that it is likely to cause death but without any intention to cause death or to cause such bodily injury as is likely to cause death.
- 304A. *Causing death by negligence*—Whoever causes the death of any person by doing any rash or negligent act not amounting to culpable homicide shall be punished with imprisonment of either description for a term which may extend to two years, or with fine or with both.
305. *Abetment of suicide of child or insane person*—If any person under eighteen years of age, any insane person, any delirious person, any idiot, or any person in a state of intoxication commits suicide, whoever abets the commission of such suicide shall be punished with death or transportation for life, or imprisonment for a term not exceeding ten years, and shall also be liable to fine.
306. *Abetment of suicide*—If any person commits suicide, whoever abets the commission of such suicide shall be punished with imprisonment of either description for a term which may extend to ten years, and shall also be liable to fine.
307. *Attempt to murder*—Whoever does any act with such intention or knowledge and under such circumstances that if he by that act caused death, he would be guilty of murder, shall be punished with imprisonment of either description for a term which may extend to ten years, and shall also be liable to fine: and if hurt is caused to any person by such act the offender shall be liable either to imprisonment for life, or to such punishment as is hereinbefore mentioned. When any person offending under this section is under sentence of imprisonment for life, he may, if hurt is caused, be punished with death.
308. *Attempt to commit culpable homicide*—Whoever does any act with such intention or knowledge, and under such circumstances that if he by that act caused death, he would be guilty of culpable homicide not amounting to murder, shall be punished with imprisonment of either description for a term which may extend to three years or with fine, or with both; and if hurt is caused to any person by such act, shall be punished with imprisonment of either description for a term which may extend to seven years, or with fine, or with both.

309. *Attempt to commit suicide*—Whoever attempts to commit suicide and does any act toward the commission of such offence, shall be punished with simple imprisonment for a term which may extend to one year, or with fine, or with both.

312. *Causing miscarriage*—Whoever voluntarily causes a woman with child to miscarry shall, if such miscarriage be not caused in good faith for the purpose of saving the life of the woman, be punished with imprisonment of either description or a term which may extend to three years, or with both, and if the woman be quick with child, shall be punished with imprisonment of either description for a term which may extend to seven years, and shall also be liable to fine.

Explanation—A woman, who causes herself to miscarry, is within the meaning of this section.

Note: “With child” means pregnant and it is not necessary to show that quickening, that is perception by the mother of the movements of the foetus has taken place or that the embryo has assumed a foetal form. The stage to which pregnancy has advanced and the form which ovum or embryo may have assumed are immaterial.

“*Quick with child*”—When the woman has felt that child moves within her.

313. *Causing miscarriage without woman’s consent*—Whoever commits the offence defined in the last preceding section without the consent of the woman, whether the woman is quick with child or not, shall be punished with transportation for life, or with imprisonment of either description for a term which may extend to ten years, and shall also be liable to fine.

314. *Death caused by act done with intent to cause miscarriage*—Whoever, with intent to cause the miscarriage of a woman with child, does any act which causes the death of such woman, shall be punished with

imprisonment of either description for term which may extend to ten years and shall also be liable to fine, and if the act is done without the consent of the woman, shall be punished either with transportation for life, or with the punishment above mentioned.

Explanation—It is not essential to this offence that the offender should know that the act is likely to cause death.

315. *Act done with intent to prevent child being born alive or to cause it to die after birth*—Whoever before the birth of any child does any act with the intention of thereby preventing that child from being born alive or causing it die after its birth, and does by such act prevent that child from being born alive or causes it to die after its birth, shall, if such act be not caused in good faith for the purpose of saving the life of the mother, be punished with imprisonment of either description for a term which may extend to ten years, or with fine or with both.

316. *Causing death of quick unborn child by act amounting to culpable homicide*—Whoever does any act under such circumstances, that if he thereby caused death, he would be guilty of culpable homicide and does by such act cause the death of a quick unborn child, shall be punished with imprisonment of either description for a term which may extend to ten years and shall also be liable to fine.

317. *Exposure and abandonment of child under twelve years by parent or person having care of it*—Whoever being the father or mother of a child under the age of twelve years, or having the care of such child shall expose or leave such child in any place with the intention of wholly abandoning for a term which may extend to seven years, or fine or with both.

Explanation—This section is not intended to prevent the trial of the offender for murder or culpable homicide, as the case may be, if the child dies in consequence of the exposor.

318. *Concealment of birth by secret disposal of dead body*—Whoever, by secretly burying or otherwise disposing of the dead body of a child, whether such child dies before or after or during its birth, intentionally conceals or endeavours to conceal the birth of such child, shall be punished with imprisonment of either description for a term which may extend to two years, or with fine, or with both.
321. *Voluntarily causing hurt*—Whoever does any act with the intention of thereby causing hurt to any person, with the knowledge that he is likely thereby to cause hurt to any person, and does thereby cause hurt to any person is said “voluntarily to cause hurt”.
322. *Voluntarily causing grievous hurt*—Whoever voluntarily causes hurt if the hurt which he intends to cause or knows himself to be likely to cause is grievous hurt, and if the hurt which he causes is grievous hurt, is said “voluntarily to cause grievous hurt”.
- Explanation*—A person is not said voluntarily to cause grievous hurt, except when he both causes grievous hurt and intends or knows himself to be likely to cause grievous hurt. But he is said voluntarily to cause grievous hurt if, intending or knowing himself to be likely to cause grievous hurt of one kind, he actually causes grievous hurt of another kind.
323. *Punishment for voluntarily causing hurt*—Whoever, except in the case provided for by Section 334, voluntarily causes hurt, shall be punished with imprisonment of either description for a term which may extend to one year, or with fine which may extend to one thousand rupees or with both.
324. *Voluntarily causing hurt by dangerous weapons or means*—Whoever, except in the case provided for by Section 334, voluntarily causes hurt by means of any instrument for shooting, stabbing or cutting or any instrument which used as a weapon of offence is likely to cause death or by means of fire or any heated substance or by means of any poison or any corrosive substance, or by means of any explosive substance, or by means of any substance which is deleterious to the human body to inhale, to swallow, or to receive into the blood, or by means of any animal, shall be punished with imprisonment of either description for a term which may extend to three years or with fine or both.
325. *Punishment for voluntarily causing grievous hurt*—Whoever except in the case provided for by Section 335, voluntarily causes grievous hurt shall be punished with imprisonment of either description for a term which may extend to seven years and shall also be liable to fine.
326. *Voluntarily causing grievous hurt by dangerous weapons or means*—Whoever, except in the case provided for by Section 335, voluntarily causes grievous hurt by means of any instrument for shooting, stabbing or cutting or any instrument which is used as a weapon of offence is likely to cause death or by means of fire or any heated substance or by means of any poison or any corrosive substance or by means of any explosive substance, which is deleterious to the body to inhale, to swallow or to receive into the blood or by means of any animal shall be punished with transportation for life or with imprisonment of either description for a term which may extend to ten years and shall also be liable to fine.
328. *Causing hurt by means of poison, etc., with intent to commit an offence*—Whoever administers to or causes to be taken by any person any poison or any stupefying intoxicating or unwholesome drug or other thing with intent to cause hurt to such person with intent to commit or to facilitate the commission of an offence, or knowing it to

- be likely that he will thereby cause hurt, shall be punished with imprisonment of either description for a term which may extend to ten years and shall also be liable to fine.
352. *Assault*—Whoever makes any gesture or any preparation, intending or knowing it to be likely that such gesture or preparation will cause any person present to apprehend that he who makes that gesture or preparation is about to use criminal force to that person, is said to commit an assault. *Explanation*—Mere words do not amount to an assault. But the words which a person uses may give to his gestures or preparations such a meaning as may make those gestures or preparations amount to an assault.
354. *Assault or criminal force to woman with intent to outrage her modesty*—Whoever assaults or uses criminal force to any woman intending to outrage or knowing it to be likely that he will thereby outrage her modesty, shall be punished with imprisonment of either description for a term which may extend to two years or with fine or with both.
366. *Kidnapping or abducting woman to compel her for marriage*—Whoever kidnaps or abducts any woman with intent that she may be compelled or knowing it to be likely that she will be compelled to marry any person against her will or order, that she may be forced or seduced to illicit intercourse, shall be punished with imprisonment of either description for a term which may extend to ten years and shall also be liable to fine.

Substitution of New Sections for Sections 375 and 376

In the Penal Code, for the heading “Of Rape” occurring immediately before Section 375 and for Sections 375 and 376, the following heading and Sections shall be substituted, namely—

‘Sexual Offences’

375. *Rape*—A man is said to commit “rape” who, except in the case hereinafter excepted, has sexual intercourse with a woman under circumstances falling under:

Firstly—Against her will.

Secondly—Without her consent.

Thirdly—With her consent, when her consent has been obtained by putting her (or any person in whom she is interested) in fear of death or of hurt.

Fourthly—With her consent when the man knows that he is not her husband, and that her consent is given because she believes that he is another man to whom she is, or believes, herself to be lawfully married.

Fifthly—With her consent, when at the time of giving such consent, by reason of unsoundness of mind or intoxication or the administration by him personally or through another of any stupefying or unwholesome substance, she is unable to understand the nature and consequences of that to which she gives consent.

Sixthly—With or without her consent when she is under sixteen years of age.

Explanation—Penetration is sufficient to constitute the sexual intercourse necessary to the offence or rape.

Exception—Sexual intercourse by a man with his own wife, the wife not being under fifteen years of age is not rape.

376. *Punishment for rape*—

- Whoever, except in the cases provided for by sub-section (2), commits rape, shall be punished with imprisonment of either description for a term which shall not be less than seven years but which may be for a life or for a term which may extend to ten years and shall also be liable to fine unless the woman raped is his own wife and is not under twelve years of age, in which case, he shall be punished with imprisonment of either description for a term which may extend to two years or with fine or with both:

2. Whoever

- (a) being a police officer commits rape—
 - (i) within the limits of the police station to which he is appointed; or
 - (ii) in the premises of any station house whether or not situated in the police station to which he is appointed; or
 - (iii) on a woman in his custody or in the custody of a police officer subordinate to him; or
- (b) being a public servant, takes advantage of his official position and commits rape on a woman in his custody as such public servant or in the custody of a public servant subordinate to him; or
- (c) being on the management or on the staff of a jail, remand home or other place of custody established by or under any law for the time being in force or of a women's or children's institution takes advantage of his official position and commits rape on any inmate of such jail, remand home, place or institution; or
- (d) being on the management of the staff of a hospital, takes advantage of his official position and commits rape on a woman in that hospital; or
- (e) commits rape on a woman knowing her to be pregnant; or
- (f) commits rape on a woman when she is under twelve years of age; or
- (g) commits gang rape, shall be punished with rigorous imprisonment for a term which shall not be less than ten years but which may be for life and shall also be liable to fine:

Provided that the court may, for adequate and special reasons to be mentioned in the judgement, impose a sentence of imprisonment of either description for a term of less than ten years or with fine.

Explanation 1—Where a woman is raped by one or more in a group of persons acting in

furtherance of their common intention, each of the persons shall be deemed to have committed gang rape within the meaning of this sub-section.

Explanation 2—"Women's or children's institution" means an institution, whether called an orphanage or a home for neglected women or children or a widow's home or by any other name, which is established and maintained for the reception and care of women or children.

Explanation 3—"Hospital" means the precincts of the hospital and includes the precincts of any institution for the reception and treatment of persons during convalescence or of persons requiring medical attention or rehabilitation.

376A. *Intercourse by a man with his wife during separation*—Whoever has sexual intercourse with his own wife, who is living separately from him under a decree of separation or under any custom or usage without her consent shall be punished with imprisonment of either description for a term which may extend to two years and shall also be liable to fine.

376B. *Intercourse by public servant with woman in his custody*—Whoever, being a public servant, takes advantage of his official position and induces or seduces any woman, who is in his custody as such public servant or in the custody of a public servant subordinate to him, to have sexual intercourse not amounting to the offence of rape, shall be punished with imprisonment of either description for a term which may extend to five years and shall also be liable to fine.

376C. *Intercourse by superintendent of jail, remand home, etc*—Whoever being the superintendent or manager of a jail, remand home or other place of custody established by or under any law for the time being in force or of a women's or children's institution takes advantage of his official position and induces or seduces any female inmate of such jail, remand home, place or

institution to have sexual intercourse with him, such sexual intercourse not amounting to the offence of rape, shall be punished with imprisonment of either description for a term which may extend to five years and shall also be liable to fine.

376D. *Intercourse by any member of the management or staff of a hospital with any woman in that hospital*—Whoever, being on the management of a hospital or being on the staff of a hospital, takes advantage of his position and has sexual intercourse with any woman in that hospital, such sexual intercourse not amounting to the offence of rape, shall be punished with imprisonment of either description for a term which may extend to five years and shall also be liable to fine.

Explanation—The expression “hospital” shall have the same meaning as in Explanation 3 to subsection (2) of Section 376.

377. *Unnatural offences*—Whoever voluntarily has carnal intercourse against the order of nature with any man, woman, or animal, shall be punished with transportation for life, or with imprisonment of either description for a term which may extend to

ten years, and shall also be liable to fine.

Explanation—Penetration is sufficient to constitute the carnal intercourse necessary to the offence described in this Section.

Of Cruelty by Husband or Relatives of Husband

498 A. *Husband or relative of husband of a woman subjecting her to cruelty*—Whoever, being the husband or the relative of the husband of a woman, subjects such woman to cruelty, shall be punished with imprisonment for a term which may extend to three years and shall also be liable to fine.

Explanation—For the purposes of this section, “cruelty” means—

- (a) any wilful conduct which is such a nature (whether mental or physical) of the woman; or
- (b) harassment of the woman where such harassment is with a view to coercing her or any person related to her to meet any unlawful demand for any property or valuable security or is on account of failure by her or any person related to her to meet such demand.



Index

A

- Abortion, 144
 - classification of, 144
 - criminal abortion, 145
 - induced abortion, 144
 - natural abortion, 144
 - therapeutic abortion, 144
 - complications of
 - immediate, 146
 - late, 146
 - methods of inducing abortion under MTP Act
 - medical method, 146
 - other methods, 146
 - surgical methods, 146
- Abrasions, 78
 - age changes in, 79
 - ante-mortem and post-mortem, 79
 - grazes, 78
 - imprint abrasion, 78
 - medico-legal importance, 77
 - pressure abrasion, 78
 - scratches, 78
- Acetoaminophen poisoning, 241
 - management, 242
 - mechanism of toxicity, 242
 - medico-legal significance, 242
 - symptoms, 241
- Acetyl salicylic acid, 241
 - fatal dose, 241
 - fatal period, 241
 - medico-legal significance, 241
 - post-mortem appearance, 241
 - symptoms, 241
 - treatment, 241
- Aconite (mitha zahar), 312
 - fatal dose, 313
 - fatal period, 313
 - Indian species of aconite, 313
 - Mechanism of action, 313
 - Medico-legal significance, 314
 - Post-mortem appearance, 314
 - symptoms, 313
 - treatment, 313
- Act of commission, 217
- Act of omission, 217
- Acute poisoning by arseniuretted hydrogen, 261
 - chemical tests of arsenic, 262
 - Gutzeit test, 263
 - Marsh's test, 263
 - Reinsch's test, 262
 - chronic poisoning, 261
 - diagnosis, 261
 - fatal dose, 261
 - fatal period, 261
 - medico-legal significance of arsenic poisoning, 263
 - organic compounds of arsenic, 260
 - post-mortem findings, 261
 - symptoms, 262
 - treatment, 261, 262
- Adipocere, 49
- Age, 14
 - medico-legal importance, 16
 - attainment of maturity, 18
 - consent, 17
 - criminal abortion, 18
 - criminal responsibility, 16
 - employment, 17

- evidence, 18
- impotence and sterility, 18
- infanticide, 18
- juvenile punishment, 17
- kidnapping, 17
- marriage contract, 18
- rape, 17
- Alcohol (ethyl alcohol), 289
 - acute poisoning, 289
 - alcohol and accidents, 294
 - alcohol and sex, 294
 - breath analysers, 294
 - chronic poisoning, 290
 - alimentary canal, 291
 - blood, 291
 - cardiovascular system, 291
 - central nervous system, 291
 - delirium Tremens, 291
 - endocrine system, 291
 - liver, 291
 - neuropsychiatric complications, 291
 - pancreas, 291
 - respiratory system, 291
 - skeletal muscle, 291
 - Wernicke-Korsakoff syndrome, 291
 - clinical symptoms, 289
 - fatal dose, 290
 - fatal period, 290
 - medico-legal significance, 293
 - pharmacokinetics of alcohol, 292
 - post-mortem appearance, 290, 292
 - treatment, 290
 - treatment of chronic alcoholic addiction, 291
 - antabuse therapy, 292
 - supportive psychotherapy, 292
 - withdrawal systems, 291
 - Widmark formulae, 294
- Alkalies, 243
 - mechanism of action, 243
- Alleged weapon of offence, 84
- Ammonia, 243
- Ammonium carbonate, 244
- Amphetamine, 304
 - acute poisoning, 304
 - chronic poisoning, 304
 - fatal dose, 304
 - medico-legal significance, 304
 - treatment, 304
- Ante-mortem burns vs post-mortem burns
 - line of redness, 72
 - reparative process, 73
 - vesication, 72
- Anthropometry, 18
- Antidotes, use of
 - chemical, 236
 - mechanical, 235
 - physiological, 236
 - specific receptor antagonist, 236
- Arsenic, 259
 - acute poisoning, 260
 - inorganic compounds of arsenic, 259
 - arsenates, 259
 - arsenic trioxide, 259
 - arsenites, 259
 - arseniuretted hydrogen, 260
 - potassium arsenite, sodium arsenites, 259
 - metallic arsenic, 259
 - organic compounds of arsenic, 260
 - sub-acute poisoning, 260
- Artefacts
 - due to decomposition, 52
 - due to environment
 - post-mortem burning, 53
 - post-mortem corrosion, 53
 - post-mortem maceration, 53
 - due to various other reasons, 53
 - third party artefacts
 - artefacts due to embalming, 53
 - artefacts during post-mortem examination, 53
 - deliberate mutilation, 53
- Artificial insemination
 - indications for donor, 113
 - indications for homologous, 113
 - legal issues
 - adultery, 114
 - future complications, 114
 - legal suits, 114
 - legality, 114
 - nullity of marriage and divorce, 114
 - medico-legal significance, 113
 - procedure, 113
- Aschheim-Zondek test, 121
- Asphyxial deaths, 54
- Asphyxiants (irrespirable gases), 317
- Assisted suicide, 163
 - medico-legal significance, 163

- Atropa belladonna*, 300
 fatal dose, 301
 fatal period, 301
 medico-legal significance, 301
 symptoms, 300
- B**
- Bacterial food poisoning, 322
 medico-legal significance, 323
 organisms
 Bacillus cereus, 322
 Campylobacter, 323
 Clostridium botulinum, 322
 E. coli, 323
 Salmonella, 322
 Shigella, 322
 Styphylococcus, 322
 Traveller's diarrhoea, 323
 Vibrio cholerae, 323
 post-mortem findings, 323
- Barberio's test, 35
- Barbiturates, 296
 chronic poisoning, 297
 clinical features, 297
 diagnosis, 297
 fatal dose, 297
 medico-legal points, 298
 pharmacokinetics, 296
 post-mortem appearance, 298
 treatment, 297
- Benzodiazepines, 298
 acute poisoning, 298
 chronic poisoning, 298
 medico-legal points, 298
 treatment, 298
- Biological stains and hair, examination of
 medico-legal importance, 32
 method
 age of stain, 34
 confirmatory test for blood, 34
 examination of blood, 32
 examination of blood stain, 33
 species identification, 34
- Blank cartridge, 88
- Bomb blast injuries, 90
 asphyxia, 90
 blast lung, 90
 burns, 90
 disruptive effect, 90
 falling masonry, 90
 flying missiles, 90
 post-mortem examination
 clothing, 91
 identification, 91
 injuries, 91
 shock wave, 90
- Brain death, Indian criteria of, 43
- Brain mapping or brain finger printing, 223
- Bruises or contusions
 age of bruise, 77
 medico-legal importance, 78
 severity of bruises, 77
- Bullet embolism, 88
- Burns
 causes of death
 Immediate causes, 70
 Late causes, 71
 classification of
 Dupuytren's classification, 69
 Heba's classifications, 69
 definitions, 69
 effects of burns
 age, 70
 duration, 70
 extent of area involved, 70
 intensity of heat, 70
 sex, 70
 site, 70
 fatal period, 71
 medico-legal significance, 72
 post-mortem findings
 external, 71
 internal, 72
- C**
- Caffey's syndrome, 142
- Calotropis gigantea* and *C. procera* (Madar), 250
 fatal dose, 250
 fatal period, 250
 medico-legal significance, 250
 symptoms, 250
 treatment, 250
- Cannabis sativa*, 301
 chronic poisoning, 302
 fatal dose, 302
 fatal period, 302

- medico-legal significance, 302
 - post-mortem appearance, 302
 - run-amok, 302
 - symptoms, 301
 - treatment, 302
- Cantharides, 275
- fatal dose, 275
 - fatal period, 275
 - medico-legal significance, 275
 - post-mortem appearance, 275
 - symptoms, 275
 - treatment, 275
- Capsicum annuum* (Red chillies), 249
- medico-legal significance, 249
 - symptoms, 249
- Carbolic acid, poisoning, 239
- fatal dose, 240
 - fatal period, 240
 - medico-legal significance, 240
 - post-mortem appearance, 240
 - symptoms, 240
 - treatment, 240
- Carbon dioxide, 317
- mechanism of action, 317
 - medico-legal significance, 318
 - post-mortem appearance, 317
 - symptoms, 317
 - treatment, 317
- Carbon monoxide, 318
- chronic poisoning, 319
 - delayed clinical features, 319
 - intoxication during pregnancy, 319
 - laboratory diagnosis, 319
 - mechanism of toxicity, 318
 - medico-legal significance, 320
 - post-mortem appearance, 320
 - sources of exposure, 318
 - spot test, 319
 - sub-acute clinical features, 319
 - symptoms, 318
 - treatment, 319
- Cardiac poisons, 310
- Cerbera thevetia* (Yellow oleander), 312
- fatal dose, 312
 - fatal period, 312
 - medico-legal significance, 312
 - symptoms, 312
 - treatment, 312
- Cerebral contusions, 106
- Cerebral lacerations, 106
- intra-cerebral haemorrhages, 107
 - punch drunkenness or goofy, 107
- Cerebral injuries
- direct cause, 105
 - indirect cause, 106
- Cerebral poisons—Deliriant poisons, 299
- Cerebral poisons—Inebriant poisons, 289
- Charak oath, 184
- Chloral hydrate, 296
- medico-legal significance, 296
 - metabolism, 296
 - physical features, 296
 - symptoms, 296
 - treatment, 296
- Chlorine, 242
- clinical features, 242
 - fatal dose, 242
 - mechanism of action, 242
 - medico-legal significance, 242
 - post-mortem features, 242
 - treatment, 242
- Chopped animal hairs, 284
- Cloning, 166
- risks of, 167
 - therapeutic, 167
 - uses of, 167
- Cocaine, 302
- acute poisoning, 302
 - chronic poisoning, 303
 - symptoms, 303
 - treatment, 303
 - medico-legal significance, 303
- Code of medical ethics, 184
- Codeine, 286
- Cold, 66
- effect of, 66
 - post-mortem findings, 67
 - external, 67
 - internal, 67
 - medico-legal importance, 67
 - treatment of, 67
- Colliquative putrefaction, 49
- factors affecting
 - external, 49
 - internal, 49
- Colocynth* (Bitter apple/indrayani), 251

- fatal dose and fatal period, 251
 - medico-legal significance, 251
 - symptoms, 251
 - treatment, 251
 - Concealed sex, 13
 - Concussion of the brain (*Commotio cerebri*), 106
 - Conduct and duties in the witness box, 10
 - Conium maculatum* (Hemlock), 308
 - fatal dose, 309
 - fatal period, 309
 - medico-legal significance, 309
 - symptoms, 309
 - treatment, 309
 - Consent, 180
 - express, 180
 - implied, 180
 - informed, 180
 - Consumer protection act and medical profession, 220
 - Contributory negligence, 217
 - Copper, 267
 - acute poisoning, 267
 - fatal dose, 267
 - fatal period, 267
 - treatment, 267
 - chronic poisoning, 267
 - symptoms, 267
 - treatment, 268
 - medico-legal significance, 268
 - post-mortem appearance, 267
 - Corporate negligence, 218
 - Corpus delicti, 11
 - Corrosive poisoning, 237
 - Court procedure, 8
 - cross-examination, 8
 - examination-in-chief, 8
 - oath, 8
 - questions put by judge, 8
 - re-examination, 8
 - Courts in India, 6
 - High court, 6
 - Magistrate courts, 7
 - Sessions court, 6
 - Supreme court, 6
 - Criminal abortion
 - causes of death
 - air-embolism, 147
 - haemorrhage, 147
 - immediate, 147
 - late, 147
 - sepsis, 147
 - sterility, 148
 - vasovagal shock, 147
 - medico-legal significance, 148
 - Criminal abortion, methods to induce
 - drugs
 - abortion pills, 147
 - emmenagogues, 147
 - irritants, 147
 - systemic poisons, 147
 - unskilled abortion, 147
 - violence
 - general, 147
 - local, 147
 - Croton tiglium* (*Croton*, *Jamalgota*), 246
 - detection of seeds, 246
 - fatal dose, 246
 - fatal period, 246
 - medico-legal significance, 247
 - post-mortem appearance, 246
 - symptoms, 246
 - treatment, 246
 - Curare, 308
 - fatal dose, 308
 - fatal period, 308
 - medico-legal significance, 308
 - symptoms, 308
 - treatment, 308
 - Custodial deaths, 164
 - Cyanide (*Hydrogen cyanide*, *HCN*), 314
 - chronic poisoning, 315
 - fatal dose, 315
 - fatal period, 315
 - mechanism of action, 314
 - medico-legal significance, 316
 - post-mortem appearance, 315
 - symptoms, 314
 - treatment, 315
- D**
- Dactylography
 - foot prints, 20
 - poroscopy, 19
 - technique of investigating fingerprints, 19
 - Deadborn
 - maceration, 138
 - mummification, 139

- Death, modes of
- asphyxia
 - clinical features, 39
 - coma, 38
 - syncope, 38
- Death, signs of
- early
 - changes in eye, 42
 - changes in skin, 42
 - cooling of body, 42
 - post-mortem staining, 42
 - immediate
 - permanent cessation of circulation and respiration, 42
 - late
 - adipocere, 42
 - mummification, 42
 - putrefaction, 42
 - rigor mortis, 42
- Definition of toxicology, 229
- classification of, 230
 - emergency management, 233
 - form, 232
 - quantity, 232
 - factors modifying action of
 - condition of the body, 204
 - mode of administration, 204
 - features of
 - poisoning in living, 232
 - poisoning in the dead, 233
 - medico-legal aspects of, 230
 - accidental poisoning, 230
 - homicidal poisoning, 230
 - suicidal poisoning, 230
 - treatment of, 234
- Deformities, 20
- Delivery, 122
- signs of recent delivery in dead, 123
 - signs of recent delivery in the living
 - abdomen, 122
 - breasts, 122
 - general physical state, 122
 - lochia, 123
 - uterus, 122
 - vagina and cervix, 122
 - signs of remote delivery in the dead, 123
 - signs of remote delivery in the living
 - abdomen, 123
 - breasts, 123
 - vagina, 123
- Detection of crime, difficulties in
- decomposition, 6
 - delay in information, 6
 - lack of medical knowledge, 6
 - rapid disposal of dead bodies, 6
- Dhatura*, 299
- fatal dose, 300
 - fatal period, 300
 - medico-legal significance, 300
 - post-mortem appearance, 300
 - symptoms, 299
 - treatment, 300
- Diamond powder, 283
- Diatom test, 63
- Digitalis purpurea*, 311
- fatal dose, 311
 - fatal period, 311
 - medico-legal significance, 312
 - symptoms, 311
 - treatment, 311
- DNA fingerprinting
- PCR technique, 168
 - laboratory procedure, 168
 - principle, 168
 - sample collection for, 169
 - structure of DNA, 168
 - uses of
 - developing treatment of genetic disorders, 169
 - diagnosis of inherited disorders, 169
 - disputed paternity, 169
 - maternity testing, 169
 - migration of population, 169
 - use in crime investigation, 169
- Drowning, 60
- cause of death, 61
 - cerebral haemorrhage, 61
 - concussion, 61
 - exhaustion, 61
 - injuries, 61
 - syncope, 61
 - vagal inhibition, 61
 - fatal period, 62
 - mechanism of, 61
 - medico-legal importance, 63
 - post-mortem findings
 - external, 62
 - internal, 62

- symptoms of, 61
 - types of, 60
 - cold water drowning, 61
 - dry drowning, 60
 - secondary drowning, 61
 - wet drowning, 60
 - Dum-Dum bullets, 88
 - Dowry death, 102
 - Dyadic deaths, 101
- E**
- Electricity, 74
 - causes of death, 74
 - duration, 74
 - judicial electrocution, 74
 - nature of current, 74
 - post-mortem findings
 - filigree burns, 75
 - Joule burn or endogenous burns, 74
 - resistance of body, 74
 - symptoms, 74
 - treatment, 74
 - Elemental mercury, 264
 - clinical features, 264
 - treatment, 265
 - Embalming, 170
 - definition, 170
 - history, 170
 - medico-legal importance, 171
 - methods of embalming
 - arterial embalming, 171
 - cavity embalming, 171
 - hypodermic embalming, 171
 - surface embalming, 171
 - present use, 170
 - preservatives used, 170
 - principle, 170
 - Ergot, 248
 - acute poisoning, 248
 - chronic poisoning (Ergotism), 248
 - fatal dose and fatal period, 248
 - medico-legal significance, 249
 - symptoms, 248
 - treatment, 249
 - Ethylene glycol, 271
 - clinical features, 272
 - fatal dose, 272
 - mechanism of action, 272
 - treatment, 272
 - Euthanasia, 162
 - reasons of, 162
 - right to commit suicide, 162
 - should a person be forced to stay alive, 162
 - unbearable pain, 162
 - types of, 162
 - active euthanasia, 162
 - passive euthanasia, 162
 - Examination of skeletal remains, 29
 - Examination of decomposed bodies, 28
 - Examination of mutilated bodies or fragments, 28
 - Exhumation, 31
 - procedure, 31
 - rules, 31
- F**
- Fibres, examination of, 37
 - Fire-arm, 81
 - range of, 82
 - smooth bored or shotguns, 81
 - Fire-arm injuries, 84
 - close-range wounds, 85
 - flame and hot gases, 84
 - projectile, 84
 - post-mortem examination, 89
 - soot particles and powder tattooing, 84
 - unusual phenomenon,
 - Kennedy, 89
 - Rayalaseema, 89
 - wounds produced
 - close-range wounds, 85
 - contact wounds, 84
 - long or out of range wounds, 86
 - short to medium range wounds, 85
 - Flash burns, 75
 - Fluorine, 243
 - fatal dose, 243
 - fatal period, 243
 - medico-legal significance, 243
 - treatment, 243
 - Food poisoning, 322
 - Forensic medicine, definitions of, 3
 - Forensic medicine, history of, 3
 - Forensic medicine in India, 4
 - Forensic psychiatry
 - abreaction, 152
 - affect, 152
 - amnesia, 152

aphasia, 152
 Binet-Simon test, 152
 circumstantiality, 152
 compulsion, 152
 delirium, 152
 delusion, 152
 dementia, 154
 erotomania, 152
 fugue state, 152
 hallucination, 153
 illusion, 153
 impulse, 153
 lilliputian, 153
 lucid interval, 153
 mental handicap, 154
 obsession, 154
 phobia, 154
 pseudologia fantastica, 152
 psychopath, 154
 psychosis and neurosis, 154, 155
 synaesthesia, 153
 trichotillomania, 153
 Foul smelling gases, 48
 Friedman test, 121

G

Galli Mainini test, 121
 Positive signs of pregnancy
 foetal heart sound, 121
 foetal movement, 121
 sonography, 122
 X-ray examination, 122
 Gastric lavage, 235
 Gettler's test, 62
 Glasgow coma scale, 234
 Gordon's classification
 anaemic anoxia, 40
 anoxic anoxia, 40
 histotoxic anoxia, 40
 stagnant anoxia, 40
 Gun powder residue, detection of, 89
 Harrison and Gilroy test, 89
 modern tests
 FASS, 89
 neutron activation analysis, 89
 SEM-DEX, 89
 paraffin test, 89
 Gutzeit test, 263

H

Hair, 18
 medico-legal importance, 18
 Hair and fibre, examination of, 36
 anatomy, 36
 examination, 36
 Halogen poisoning, 242
 Handwriting, 21
 Hanging, 54
 atypical or partial hanging, 54
 cause of death in hanging
 asphyxia, 55
 cerebral ischemia, 55
 combined asphyxia and venous congestion, 55
 fracture or dislocation of cervical vertebrae, 55
 venous congestion, 55
 ligature, 54
 management of, 55
 medico-legal importance, 56
 post-mortem changes, 55
 external examination, 55
 internal examination, 56
 symptoms of, 55
 typical, 54
 Head injury, 103
 meningeal haemorrhages,
 extra-dural haemorrhage, 104
 sub-dural haemorrhage, 105
 scalp injury, 103
 skull fracture
 basilar fracture, 104
 comminuted fracture, 103
 contre-coup fractures, 104
 depressed fracture, 103
 diastatic fracture, 104
 gutter fracture, 104
 linear or fissured fractures, 104
 pond or indented fracture, 104
 ring fracture, 104
 Heat, 67
 effects of, 67
 heat cramps, 68
 heat exhaustion, 67
 heat fatigue, 67
 heatstroke, 67
 heat syncope, 67
 medico-legal importance, 67
 post-mortem findings, 67
 treatment, 68

- Heat haematoma, 72
 Heroin, 286
 Honour killings, 101
 Hogben or Xenopus test, 121
 Homicidal or criminal causes, 141
 act of commission, 141
 drowning, 141
 mechanical violence, 142
 poisoning, 142
 strangulation, 141
 suffocation, 141
 act of omission, 142
 relevant legal sections, 142
 Hooch tragedies, 296
 Hydrochloric acid, 239
 fatal dose, 239
 fatal period, 239
 medico-legal significance, 239
 post-mortem appearance, 239
 properties, 239
 special symptoms, 239
 Hymen, types of, 117
 annular, 117
 cribriform, 117
 fimbriated, 117
 imperforate, 117
 septate, 117
 Hypnosis, 161
- I**
- Iatrogenic electrocution, 75
 Identification, 11
 complexion and features, 18
 Impotence, 111
 Impotence/Sterility in males, causes of
 age, 111
 congenital malformations, 111
 local trauma or diseases, 111
 psychological, 112
 systemic diseases, 112
 Impotence/Sterility in the female, causes of
 age, 112
 congenital malformations, 112
 local trauma or diseases, 112
 psychological, 112
 systemic diseases, 112
 Incest, 128
 Infanticide, 138
 Inorganic acid poisoning, 237
 local applications, 237
 mechanism of action, 237
 treatment, 237
 Inorganic poisoning, 252
 Inquest, 5
 Coroner's inquest, 5
 magistrate inquests, 6
 medical examiner system, 6
 police inquest, 5
 Insanity, 150
 causes of, 150
 environmental factors, 150
 heredity, 150
 organic causes, 150
 definition of, 150
 onset of, 150
 Insulin poisoning, 282
 Iodine, 242
 clinical features, 243
 fatal dose, 243
 medico-legal significance, 243
 post-mortem features, 243
 treatment, 243
 Iron, 272
 fatal dose, 272
 fatal period, 272
 medico-legal significance, 273
 post-mortem features, 273
 symptoms, 272
 treatment, 272
 Irritant poisons—animal poisons, 275
 Irritant poisons—non-metallic (Inorganic)
 mechanism of action, 252
 Irritant poisons—metallic poisons (Inorganic), 259
 Isopropanol, 271
 clinical symptoms, 271
 fatal dose, 271
 treatment, 271
- J**
- Juar kadvi, 316
- K**
- Klinefelter's syndrome, 12
- L**
- Lacerations
 avulsions, 80
 cut laceration, 80

- split, 80
 - stretch laceration, 80
 - tears, 80
 - Lead, 268
 - acute poisoning
 - fatal dose, 269
 - fatal period, 269
 - sub-acute form, 269
 - treatment, 269
 - chronic poisoning (plumbism or saturnism), 269
 - clinical features, 269
 - diagnosis, 270
 - post-mortem appearance, 271
 - treatment, 270
 - Legal procedures, 5
 - Legitimacy, 135
 - medico-legal aspects of, 135
 - disputed paternity, 135
 - fictitious child, 135
 - inheritance, 135
 - medico-legal considerations
 - duration of pregnancy, 135
 - maximum period of pregnancy, 135
 - minimum period of pregnancy, 135
 - paternity, 136
 - superfecundation, 135
 - superfetation, 136
 - Lesbianism, 129
 - Lightning, 73
 - effect of, 73
 - medico-legal significance, 73
 - Lysergic acid diethylamide (LSD), 304
 - clinical features, 305
 - fatal dose, 305
 - treatment, 305
- M**
- Marriage annulment, 136
 - adultery, 136
 - cruelty, 137
 - desertion, 137
 - impotence, 136
 - wife battery, 137
 - Marsh's test, 263
 - McNaughten rule, 160
 - Mechanical poisons, 283
 - Medical ethics, 184
 - Medical evidence, 8
 - documentary evidence, 8
 - dying declaration, 9
 - dying deposition, 9
 - medical certificate, 8
 - medico-legal reports, 9
 - oral evidence, 9
 - Medical negligence, 216
 - types of, 217
 - civil negligence, 217
 - criminal negligence, 217
 - Medico-legal aspects of sexual offences, 133
 - date rape, 133
 - false charges, 134
 - rape during sleep or unconsciousness, 133
 - rape trauma syndrome, 133
 - Medico-legal aspects of wounds
 - age of injury, 96
 - causes of death
 - air embolism, 97
 - death due to medical intervention, 98
 - death due to supervened disease because of trauma, 98
 - fat embolism, 97
 - gangrene, 97
 - haemorrhage, 97
 - infection, 97
 - injury to vital organ, 97
 - shock, 97
 - thrombosis in veins, 97
 - enzyme changes, 98
 - medico-legal importance, 99
 - Medico-legal issues in AIDS and STD
 - legal rights, 133
 - medical issue, 132
 - social and ethical issues
 - absolute privilege, 132
 - qualified privilege, 132
 - Mental diseases, classification of, 151
 - drug dependence, 152
 - neurosis, 151
 - Personality disorders, 152
 - psychosis, 151
 - functional psychosis, 151
 - organic psychosis, 151
 - sexual perversions, 152
 - Mercury, 264
 - Mercury, inorganic salts of, 265
 - chronic poisoning, 266
 - clinical features, 265
 - fatal dose, 265

- fatal period, 265
 - laboratory diagnosis, 265
 - post-mortem findings, 266
 - treatment, 265
 - Mercury, organic compounds of, 266
 - clinical features, 266
 - ethyl mercury, 267
 - mercurochrome, 267
 - methyl mercury, 266
 - phenyl mercury, 267
 - treatment, 267
 - Methods of identification, miscellaneous, 21
 - clothes and personal articles, 21
 - gait, 21
 - mental power, memory and education, 21
 - speech and voice, 21
 - ticks, manners and habit, 21
 - Methyl alcohol, 295
 - antidote, 295
 - fatal dose, 295
 - fatal period, 295
 - mechanism of action, 295
 - medico-legal significance, 295
 - post-mortem appearance, 295
 - symptoms, 295
 - treatment, 295
 - Morphine, 285
 - Mummification, 50
 - Mushroom poisoning, 324
 - clinical features, 324
 - long incubation poisoning, 324
 - short incubation poisoning, 324
 - medico-legal significance, 325
 - structure of a mushroom, 324
 - treatment, 325
- N**
- Narco-analysis or truth serum test, 222
 - Needles and pins, 284
 - Nerium odorum* (Kaner or White oleander), 312
 - fatal dose, 312
 - fatal period, 312
 - medico-legal significance, 312
 - symptoms, 312
 - treatment, 312
 - Neurosis, 151,155
 - anxiety, 155
 - depression, 156
 - endogenous, 156
 - hypochondriacal, 156
 - involutional, 156
 - puerperal, 156
 - reactive, 156
 - hysterical, 156
 - obsessive-compulsive, 156
 - Neurotic poisons—somniferous poisons, 285
 - Nitric acid, 239
 - chemical properties, 239
 - fatal dose, 239
 - fatal period, 239
 - medico-legal significance, 239
 - post-mortem appearance, 239
 - special poisoning symptoms, 239
 - Non-metallic poisons, 252
 - aluminium phosphide poisoning, 256
 - fatal dose, 257
 - fatal period, 257
 - laboratory test, 257
 - mechanism of toxicity, 256
 - medico-legal significance, 258
 - mild poisoning, 257
 - moderate poisoning, 257
 - post-mortem appearance, 258
 - procedure, 257
 - severe poisoning, 257
 - symptoms, 257
 - treatment, 257
 - chronic phosphorus poisoning, 253
 - medico-legal significance, 254
 - treatment, 254
 - organophosphorus and carbamates poisoning, 254
 - antidotes, 255
 - confirmation test (laboratory methods), 255
 - fatal dose, 255
 - fatal period, 255
 - mechanism of action, 254
 - medico-legal importance, 256
 - post-mortem appearance, 256
 - specific reactivator oximes, 256
 - symptoms, 254
 - treatment, 255
 - phosphorus poisoning, 252
 - fatal dose, 253
 - fatal period, 253
 - liver failure, 253
 - mechanism of action, 253
 - post-mortem findings, 253

- symptoms, 252
 - treatment, 253
 - pyrethrins and pyrethroids, 258
- O**
- Occupational marks, 21
 - Opium, 285
 - acute poisoning, 286
 - codeine, 286
 - differential diagnosis, 287
 - apoplexy, 287
 - acute alcohol poisoning, 287
 - barbiturate poisoning, 287
 - carbolic acid poisoning, 287
 - diabetic coma, 287
 - epileptic coma, 287
 - head injury, 287
 - hysterical coma, 287
 - ureamic coma, 287
 - fatal dose, 287
 - fatal period, 287
 - heroin, 286
 - medico-legal significance, 288
 - morphine, 285
 - post-mortem findings, 288
 - treatment, 287
 - unusual symptoms, 286
 - Organic acid poisoning, 239
- P**
- Peripheral nerve poisons, 308
 - Perjury, 8
 - Permanent cessation of circulation and respiration
 - diaphanous test, 43
 - Icard's test, 43
 - magnus test, 43
 - Phencyclidine, 305
 - clinical features, 305
 - medico-legal significance, 305
 - toxic dose, 305
 - Plumbago rosea* (Lai chitra), 250
 - medico-legal significance, 251
 - symptoms, 251
 - Plumbago zeylanica*, 250
 - Poisonous food, 323
 - Argemone mexicana*, 323
 - Lathyrus sativus*, 323
 - Poisonous insects, 281
 - ants, 281
 - scorpions, 282
 - wasp, bees hornets, 281
 - Poisons, 229
 - Poison Information Centers, 236
 - Polygraph or lie detector test, 222
 - Post-mortem calorificity, 46
 - Post-mortem examination, 22
 - alternative way of,
 - endoscopic autopsy, 27
 - psychological autopsy, 27
 - cause of death, 27
 - external examination, 23
 - internal examination, 24
 - examination of head, 24
 - examination of thorax and abdomen, 24
 - intestines, 25
 - liver, 25
 - spine and spinal cord, 25
 - stomach, 25
 - uterus, 25
 - preservation of viscera, 26
 - Post-mortem staining, 46
 - Potassium carbonate, 244
 - Potassium hydroxide, 244
 - Powdered glass, 283
 - fatal dose, 283
 - fatal period, 283
 - medico-legal significance, 283
 - post-mortem appearance, 283
 - symptoms, 283
 - treatment, 283
 - Pregnancy, 122
 - medico-legal significance of, 122
 - civil cases, 122
 - criminal cases, 122
 - presumptive signs, 119
 - cessation of menstruation, 120
 - changes in breasts, 120
 - changes in vagina, 120
 - frequency of micturition, 120
 - morning sickness, 120
 - pigmentation of skin, 120
 - quickening, 120
 - sympathetic changes, 120
 - Probable signs, 120
 - ballottement, 121
 - Braxton Hicks sign, 120

- changes in cervix, 120
 - endocrine tests, 121
 - enlargement of abdomen, 120
 - Hegar's sign, 120
 - palpation of foetus, 121
 - uterine souffle, 121
 - Pregnancy in dead, 122
 - signs of, 122
 - corpus luteum, 122
 - presence of foetus or ovum, 122
 - uterine changes, 122
 - Pregnancy, medical termination of, 144
 - Propellant charge, 83
 - black powder, 83
 - smokeless powder, 84
 - double base powder, 84
 - single base powder, 84
 - triple base powder, 84
 - Pseudohermaphroditism, 13
 - Psychosis, 155
 - manic-depressive, 155
 - depressive phase, 155
 - mania phase, 155
 - schizophrenia, 155
 - catatonic, 155
 - hebephrenia, 155
 - paranoid schizophrenia, 155
 - simple schizophrenia, 155
- R**
- Race, 11
 - complexion, 11
 - eyes, 11
 - hair, 11
 - skeleton, 12
 - Rape, 124
 - age, 125
 - custodial rape, 124
 - definition, 124
 - examination
 - clothes, 126
 - genitals, 126
 - injuries, 126
 - examination of victim, 125
 - prevalence of rape, 125
 - punishment for rape, 124
 - socio-economic status, 125
 - Rape trauma syndrome, 133
 - Abrus precatorious* (Ratti), 247
 - fatal dose, 247
 - fatal period, 247
 - medico-legal significance, 248
 - post-mortem appearance, 248
 - symptoms, 247
 - treatment, 248
 - Regional injuries, 103
 - Reinsch's test, 262
 - Retained bullets, 88
 - Ricochet bullet, 88
 - Ricinus communis* (Castor oil plant, Arandi), 245
 - fatal dose, 245
 - fatal period, 245
 - medico-legal significance, 246
 - post-mortem appearance, 246
 - symptoms, 245
 - treatment, 246
 - Rifled fire-arms, 82
 - hand guns, 82
 - pistols, 82
 - revolvers, 82
 - rifles, 82
 - Rigor mortis, 47
 - cadaveric spasm, 47
 - cold stiffening, 47
 - heat stiffening, 47
- S**
- Salivary stains, examination of, 36
 - Scars, 20
 - Semecarpus anacardium* (marking nut tree), 249
 - fatal dose, 250
 - fatal period, 250
 - medico-legal significance, 250
 - symptoms, 249
 - Seminal stains, examination of, 35
 - chemical tests, 35
 - acid phosphatase isoenzyme method, 35
 - acid phosphatase spot test, 35
 - Barberio's test, 35
 - florence test, 35
 - LDH isoenzyme method to detect spermatozoa, 35
 - zinc test, 35
 - identification of species, 36
 - immunological method, 36
 - LDH isoenzyme method, 36
 - microscopic method, 36
 - individual identification, 36

- microscopic examination, 35
- visual examination, 35
- Sex, 12
 - clinical method, 12
 - investigations
 - intersex, 12
 - sex chromatin study, 12
- Sexual deviations, 130
 - exhibitionism, 130
 - fetishism, 130
 - frotteurism, 131
 - masochism, 130
 - necrophilia, 130
 - nymphomania, 130
 - paedophilia, 130
 - sadism, 130
 - satyriasis, 131
 - scotophilia, 130
 - transvestism, 130
 - troilism, 130
 - undinism, 131
 - voyeurism (peeping tom), 130
- Sexual harassment, 131
 - criminal proceedings, 131
 - definition, 131
- Sexual offences, 124, 133
- Sexually transmitted disease (STD), 127
- Shotguns, wounds produced by
 - close range, 87
 - contact wounds, 87
 - short range to medium range, 88
- Snakes (Ophidia), 276
 - non-poisonous snakes, 279
 - fatal dose, 279
 - first aid, 280
 - hospital treatment, 281
 - local reaction, 279
 - medico-legal significance, 281
 - post-mortem appearances, 281
 - specific findings in snake bites, 280
 - symptoms of snake venom poisoning, 279
 - treatment, 280
 - poisonous snakes, 276
 - banded krait, 277
 - black krait, 277
 - cobra, 276
 - common krait, 277
 - king cobra, 277
 - viperidae, 277
 - snake venom, 278
- Sodium carbonate, 244
- Sodium hydroxide, 244
- Somnambulism, 161
- Spectacle haematoma, 103
- Spinal injuries, 107
 - concussion of spine or railway spine, 107
 - Hangman's fracture, 107
 - whiplash injury, 107
- Spinal poisons, 306
- Starvation, 65
 - acute starvation, 65
 - chronic starvation, 65
 - clinical features, 65
 - medico-legal importance, 66
 - post-mortem findings
 - external, 66
 - internal, 66
- Sterility, 111
 - examination of, 111
- Strangulation, 57
 - bans-dola, 57
 - garroting, 57
 - medico-legal importance, 58
 - mugging, 57
 - post-mortem findings, 57
 - external, 57
 - internal, 58
 - throttling, 57
- Strychnous nux vomica*, 306
 - fatal dose, 307
 - fatal period, 307
 - mechanism of action, 306
 - medico-legal significance, 308
 - post-mortem findings, 308
 - symptoms, 307
 - treatment, 307
- Sudden death, 40
 - causes, 40
 - diseases of alimentary system, 41
 - diseases of cardiovascular system, 40
 - diseases of central nervous system, 41
 - diseases of genitourinary system, 41
 - diseases of respiratory system, 40
 - systemic diseases, 41
- Sudden infant death syndrome or Cot deaths, 142
- Suffocation, 58

- causes, 58
 café coronary, 59
 choking, 59
 inhalation of irrespirable gases, 59
 smothering, 58
 traumatic asphyxia, 59
 medico-legal importance, 60
 post-mortem findings
 external, 60
 internal, 60
- Sulphuric acid (H_2SO_4), 238
 fatal dose, 238
 fatal period, 238
 medico-legal significance, 238
 post-mortem appearance, 238
 special symptoms, 238
 vitriolage (Acid throwing), 238
- T**
- Tandem bullet, 88
 Tattoo marks, 20
 Test tube baby or *in vitro* fertilisation, 114
 medico-legal issues, 114
 surrogate mother, 114
 Thallium, 273
 fatal dose, 273
 fatal period, 273
 mechanism of action, 273
 medico-legal points, 274
 post-mortem appearance, 274
 symptoms, 273
 treatment, 273
 Time since death, 51
 Tobacco (*Nicotiana tabacum*), 310
 acute poisoning, 310
 chronic poisoning, 311
 fatal dose, 310
 fatal period, 310
 medico-legal significance, 311
 treatment, 311
 Torture, 163
 methods of, 163
 physical torture, 163
 psychological torture, 164
 sexual torture, 164
 Traffic injuries, 109
 injuries to driver, 109
 injuries to non-driver occupants, 109
 injuries to pedestrians, 109
 crush injuries, 109
 primary impact injuries, 109
 secondary impact injuries, 109
 secondary injuries, 109
 injuries to two wheeler drivers, 110
 True hermaphroditism, 13
 Turner's syndrome, 13
- U**
- Unabsorbed poison, 234
 Unnatural sexual offences, 128
 classification, 129
 bestiality, 129
 buccal coitus, 129
 sodomy, 129
 incidence, 128
- V**
- Vegetable hairs, 284
 Vegetable poisons, 245
 Virginity, 117
 medico-legal aspects, 119
 signs of, 117
 breasts, 119
 genitalia, 117
 Voice stress test, 223
- W**
- War gases, 320
 asphyxiants, 320
 nasal irritants, 321
 nerve gases, 321
 paralyzants, 321
 tear gases, 320
 vesicating agents, 320
 Witness, types of, 10
 common, 10
 expert, 10
 Workmen's Compensation Act, 1923, 171
 Wounds, 79
 incised wound, 79
 lacerated wounds, 80
 stab or punctured wounds, 79
 Writing analysis or graphology, 223

Concise Textbook *of* Forensic Medicine & Toxicology

3rd
Edition

The present book is a thoroughly revised and updated version of the earlier edition. It is designed to suit an undergraduate student's need of quick study of the subject while preparing for examinations. The text faithfully follows the curriculum prescribed by the Medical Council of India.

Key Features

- Includes contemporary developments like cloning, euthanasia, date rape and drug facilitated sexual assaults.
- Toxicology is discussed as per standard clinical practice.
- Chapters on medical negligence include concepts like comparative negligence and post-CPA scenario in medical practice.
- The chapter sequence is designed as per the teaching schedule in medical colleges.
- Incorporated detailed discussion vis-à-vis related legal provision in a systematic manner.
- Text is illustrated with photographs, line drawings, sketches and tables.

NEW TO THIS EDITION

- Chapter, Recent Advances in Crime Detection featuring new concepts like lie detector test, narco-analysis, brain mapping, hypnosis and voice stress test.
- Updation of chapters, Insanity and Forensic Psychiatry and Sexual Offences.
- Thorough revision of topics like collection of samples for DNA fingerprinting in living and dead cases.
- Line diagrams in some chapters and photographs (forensic slides) at the end of Section I: Forensic Medicine for better appreciation of concepts.
- Tables in various chapters for greater understanding and quick recapitulation during examination.
- Appendix highlighting characteristics of some toxic agents for usefulness in toxicology.

This comprehensive, yet concise textbook is ideal for undergraduate students of Forensic Medicine. It would also be useful for students of Ayurvedic, Homoeopathic, Unani and Siddha systems of medicine.

About the Author



Dr R K Sharma joined All India Institute of Medical Sciences, New Delhi in 1977 as undergraduate student. Later after completion of his post-graduation in Forensic Medicine, he joined as faculty member. He served as Head of the department and later took voluntary retirement to pursue his medico-legal goals. He is examiner to various universities in India. He has authored more than 65 international papers. He has written five books and publishes five international journals. He has supervised many scientific projects of national and international importance. He is currently working as Dean (R & D), Saraswathi Institute of Medical Sciences, Hapur, Uttar Pradesh.

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