CHAPTER 26
CORROSIVE POISONS

A corrosive poison fixes, destroys and erodes the surface with which it comes in contact. They act by extracting water from the tissues, and coagulate cellular proteins, and convert haemoglobin into haematin.

MINERAL ACIDS

An exothermic reaction occurs when strong mineral acids, e.g. sulphuric acid comes into contact with moist skin. The heat together with corrosion causes coagulation necrosis. This crust may prevent further penetration of acid. The hydrogen ions from the acid are neutralised fairly quickly and deep penetrating tissue destruction does not occur. Hydrofluoric acid causes liquefaction necrosis. They have no remote action. They act as irritants when slightly diluted, but as stimulants when well diluted.

SULPHURIC ACID

Pure sulphuric acid (oil of vitriol; H_2SO_4) is a heavy, odourless, colourless, non-fuming, hygroscopic, oily liquid, and has tendency to carbonise organic substances. Commercial sulphuric acid is usually brown or dark in colour.

Signs and Symptoms: The lips are usually swollen and excoriated and brown or black streaks may be found extending from the angles of the mouth to the sides of the chin, and sometimes to the front of the neck due to flow of the acid. There is corrosion of mucous membranes of mouth, throat and oesophagus, immediate burning pain stridor, drooling, odynophagia and dysphagia. Epigastric pain soon spreads all over the abdomen and thorax. Pharyngeal pain is the most common presenting symptom. Eructation, nausea and vomiting occur. The vomit is brown or black, mucoid, strongly acid, and may contain shreds of the charred wall of the stomach. Thirst is intense, but any attempt to drink causes vomiting. Circulatory collapse may cause immediate death or may result from asphyxia due to oedema of the glottis. Teeth are chalky-white. Tongue becomes swollen, sodden and black. The abdomen becomes distended and very tender. Constipation is severe, and there is tenesmus. The voice becomes hoarse and husky. The eyes are sunken and the pupils usually dilated. The mind remains clear till death. If person recovers, late oesophageal, gastric and pyloric strictures and stenoses may develop. Permanent scars may also appear in the skin and oropharynx.

Fatal Dose: 10 to 15 ml.

Fatal Period: 12 to 24 hours.

Cause of Death: (1) Circulatory collapse. (2) Spasm or oedema of glottis. (3) Collapse due to perforation of stomach. (4) Toxaemia. (5) Delayed death may occur due to hypostatic pneumonia, secondary infection, renal failure, or starvation due to stricture of oesophagus.

Complications: (A) Acute: (1) Upper airway obstruction and injury. (2) G.I. haemorrhage. (3) Oesophageal and gastric perforation. (4) Sepsis. (5) Tracheobronchial necrosis, atelectasis and obstructive lung injury. **(B) Chronic:** (1) Oesophageal obstruction. (2) Pyloric stenosis. (3) Vocal cord paralysis with airway obstruction.

Treatment: (1) Avoid gastric lavage or emetics. (2) The acid should be immediately diluted and neutralised *in situ* by giving one-fourth litre of water or milk or milk or magnesia or lime water or soap suds or aluminium hydroxide gel, if the patient is seen within 30 minutes of ingestion. Alkaline carbonates and bicarbonates, which liberate carbon dioxide should not be used, as they cause gastric distension and sometimes rupture. (3) Give a demulcent: olive oil, milk, egg-whites, starch water, mineral oil, melted butter. (4) Prednisolone 60 mg./day may be given in divided doses to prevent oesophageal stricture and for shock. Later on 4 cm. diameter mercury-filled bougie should be passed daily if stricture develops. (5) Correct circulatory shock. (6) Tracheostomy, if there is oedema of glottis. (7) Give nothing by mouth. Nutrient substances are given by intravenous route for about a week. Then try liquids, soft food, and finally a regular diet. (8) Skin burns are washed with large amounts of water and a paste of magnesium oxide or sodium bicarbonate is applied. (9) Eye burns are irrigated with water or sodium bicarbonate solution for 10 to 15 minutes. A suspended i.v. bag that administers low pressure irrigation is ideal. (10) Symptomatic.

Post-mortem Appearances: They depend on the quantity and strength of the acid used, and the time that the patient survives after taking the acid.

Corrosion of mucous membranes of lips, mouth and throat, and of the skin over the chin, angles of the mouth, and hands is seen.The necrotic areas are at first grayish-white, but soon become brown or black and leathery. The clothing should be examined for burns and stains.

Internal: Internal changes are limited to the upper digestive tract, and the respiratory system. The upper digestive tract is inflamed and swollen by oedema and severe interstitial haemorrhage, even when corrosion is absent. When the acid is taken from a spoon, lips and mouth escape injury. In acid burns, the squamous epithelium of the oesophagus is usually relatively resistant and superficial mucosal reaction is produced. Acids have their major effects on columnar epithelium of the stomach, leading to superficial erosion and coagulation with eschar formation. Perforation of the oesophagus is rare. The greater part of stomach may be converted into a soft, spongy, black mass which readily disintegrates when touched. Sometimes, only the pyloric region is involved, because fluid pathway from oesophagus occurs usually along lesser curvature to the pylorus. Initial exposure of the pylorus to acid causes severe spasm, which promotes injury at this site. The mucosal ridges are more damaged than the intervening furrows. In the damaged area, the mucosa or even the whole thickness of the stomach wall has a brown or black colour. Perforation may occur with the escape of gastric contents into the peritoneal cavity, and if the patient lives for few hours, chemical peritonitis and corrosion of organs is seen. Perforation of diaphragm may occur. The duodenum may show similar but less intense changes, and the small intestine may show signs of irritation. In many cases, little or no free acid can be found in the viscera, because the acid is converted to substances normally present in the body especially if the victim has survived for 2 days or more. Corrosion or severe inflammation of the larynx and trachea may be present. Secondary toxic swelling of the liver and kidney is seen if person survives longer.

Time course of injury: (1) Acute inflammatory stage occurs during first 4 to 7 days. (2) Granulation stage starts on 4th day and ends on 7th day. (3) Perforation most often occurs between 7 to 12 days, but may occur earlier. (4) Cicatrisation (stricture) stage starts at 3 weeks and may persist for years.

TESTS : For mineral acids or alkalis, the only material suitable for analysis is that found in the stomach. (1) Strong acid chars organic matter. (2) Barium nitrate or chloride solution produce a white precipitate of barium sulphate.

The Circumstances of Poisoning: Accidental poisoning results due to mistaking it for glycerine or castor oil or from inhalation of vapour in chemical factories. (2) Most cases are suicidal. (3) It is not used for homicide, because of its acid taste, almost immediate local action, and the physical changes which it produces in the food. (4) It is taken internally or injected into vagina as abortifacient.

VITRIOLAGE (vitriol throwing): Throwing of sulphuric acid on another individual is known as vitriolage. Jealous or disgruntled persons may throw a corrosive to disfigure and harm their enemies. Blindness may occur if the eyes are involved. Death may result from shock or toxaemia, if extensive area is involved. The burns are painless. They are penetrating burns and the acid devitalises the tissues and predispose to infection. Repair is slow and the scar tissue causes contracture. Sometimes, corrosive alkali or juice of marking nut or calotropis is used to disfigure the face.

Treatment: Wash the affected parts with plenty of water and soap or sodium or potassium carbonate. Later, a thick paste of magnesium oxide or carbonate is applied. The eyes are washed with water and irrigated with a dilute sodium bicarbonate solution. Later, a few drops of olive oil or castor oil are instilled into the eyes.

NITRIC ACID (HNO_3)

Nitric acid (aqua fortis; red spirit of nitre) is a clear, colourless, fuming, heavy liquid, and has a peculiar and choking odour. In concentrated form it combines with organic matter and produces an yellow discolouration of tissue due to the production of picric acid **(xanthoproteic reaction).**

Signs and Symptoms : They are those of poisoning by sulphuric acid. There is more eructation and greater abdominal distention owing to gas formation. It causes yellow discolouration of the tissues, including the crowns of the teeth and yellow stains on the clothing. Inhalation of fumes causes lachrymation, photophobia, irritation of air-passages and lungs producing sneezing, coughing, dyspnoea and asphyxia.

Fatal Dose: 10 to 15 ml.

Fatal Period: 12 to 24 hours.

Post-mortem Appearances: They are those of sulphuric acid, but the tissues are stained yellow. In the oesophagus and stomach, corrosion of mucous

membrane may not be accompanied by yellow discolouration, which may appear brown or brown-black due to acid haematin. The stomach wall is soft, friable and ulcerated. Perforation of the stomach is not common but extensive areas of the mucosa of the stomach or oesophagus are sometimes detached.

In death from inhalation of fumes, the larynx, trachea, and bronchial tubes are congested and lungs are oedematous.

TREATMENT: Same as for sulphuric acid.

TEST: The test is for the presence of nitrates. If strong ferrous sulphate solution and sulphuric acid are added to a solution containing nitric acid, a brown ring is formed at the junction of the two fluids.

THE CIRCUMSTANCES OF POISONING: Most cases of poisoning are the result of an accident or suicide. Homicide by this acid is rare.

HYDROCHLORIC ACID (HCL)

Hydrochloric acid (muriatic acid) is pungent, colourless, fuming liquid. It is a natural constituent of the fluid of the stomach and bowels.

Signs and Symptoms: It is less corrosive in its action than sulphuric acid. It does not usually corrode or seriously damage the skin, but it readily destroys mucous membrane. The mucous membrane is at first grey or grey-white, and later becomes brown or black, due to the production of acid haematin. Inhalation of fumes causes intense irritation of throat and lungs with symptoms of suffocation, coughing, dyspnoea and cyanosis. Constant exposure to fumes produces chronic poisoning characterised by coryza, conjunctivitis, corneal ulcer, pharyngitis, bronchitis, inflammation of gums and loosening of teeth.

Fatal Dose: 15 to 20 ml.

Fatal Period: 12 to 24 hours.

Treatment: Same as for sulphuric acid.

Post-mortem Appearances: They are those produced by sulphuric acid, although corrosion is less severe. The stomach contains brownish fluid. The folds of the whole stomach mucosa are brownish. Perforation of the stomach is rare. Acute inflammation and oedema of respiratory passages and lung tissue are common.

TEST: A solution of silver nitrate produces a heavy, curdy, white precipitate of silver chloride.

The Circumstances of Poisoning: Most cases of poisoning are suicidal. A few are accidental or homicidal. Rarely it is injected into the vagina to produce abortion.

Fig. (26–1). Corrosive acid burns with dribbling marks on front of the chest.

OXALIC ACID

Oxalic acid (acid of sugar, salt of sorrel, $C_2H_2O_4$) occurs in the form of colourless, transparent, prismatic crystals, and resembles in appearance the crystals of magnesium sulphate and zinc sulphate. In the form of oxalate, it exists as a natural constituent of many plants, e.g. spinach, rhubarb, cabbage, etc. About 20 mg. is excreted in urine daily. It is used as a bleach to remove stains, or to clean brass or copper articles or leather, in calico-printing, and for removing writing and signature illegally.

Action: Local: Crystals of the acid and concentrated solution of oxalates are corrosive poisons. They rarely damage the skin, but readily corrode the mucous membrane of the digestive tract. They do not lose their poisonous properties when diluted. Dilute solutions act as mild local irritants, but cause serious systemic effects when absorbed.

Systemic: (a) Shock: Large doses cause rapid death from shock. **(b) Hypocalcaemia:** Those who survive for a few hours develop hypocalcaemia, because it readily combines with the clacium ion in the body tissues and causes its withdrawal from them. **(c) Renal damage:** Oxalates produce tubular nephrosis or necrosis and cause death from uraemia in two to fourteen days.

Fatal Dose: 15 to 20 g.

Fatal Period: 1 to 2 hours.

Signs and Symptoms: (a) Fulminating Poisoning: Large concentrated dose of 15 g. or

more produce immediate symptoms and death within minutes. There is a burning, sour, bitter taste in the mouth with a sense of constriction around the throat and burning pain from the mouth to the stomach. Pain is very severe, begins in the epigastrium, but soon radiates all over the abdomen; there may be tenderness. Nausea and eructations are immediately followed by vomiting which may be persistent. Vomit usually contains altered blood and mucus and has a "coffee-ground" appearance. Thirst may be present. Death usually occurs before bowels are affected, but if life is prolonged diarrhoea will occur.

(b) Acute Poisoning: It occurs by a large dose, when the patient survives for a few hours, and is characterised by symptoms of hypocalcaemia, and less by digestive upset. There is muscle irritability and tenderness, tetany or usually convulsions. There may be numbness and tingling of the fingertips and legs. Usually, signs of cardiovascular collapse appear. In some patients stupor and coma occur.

(c) Delayed Poisoning : It is characterised by the symptoms of uraemia. The urine may be scanty or suppressed and may contain traces of blood, albumin and calcium oxalate crystals. There may be metabolic acidosis and ventricular fibrillation.

Treatment: (1) The stomach is washed out carefully using calcium lactate or gluconate, two teaspoonfuls in each lavage. (2) The antidote for oxalate poisoning is any preparation of calcium which converts the poison into insoluble calcium oxalate, e.g. lime water, calcium lactate, calcium gluconate, calcium chloride, a suspension of chalk in water or milk. One-and-half g. of chalk will neutralise about one gram of oxalic acid. (3) Calcium gluconate 10%, 10 ml. i.v. at frequent intervals. (4) Dialysis or exchange transfusion for renal failure. (5) Parathyroid extract 100 units i.m. in severe cases. (6) Demulcent drinks. (7) The bowels may be evacuated by an enema or by castor oil. (8) Symptomatic.

Post-mortem Appearances: Burns of the face and skin are rare. If the poison has been used in strong solution, the mucous membrane of the tongue, mouth, pharynx and oesophagus will be whitened as if bleached and has a scalded appearance, but is sometimes reddened by irritation. The inner surface of the oesophagus is corrugated and shows longitudinal erosions. The mucous membrane of the stomach is reddened or punctate from erosions or almost black. It may be softened in patches but perforation is very rare. Numerous dark-brown or black streaks run along the length of the stomach over the mucous membrane often with intercommunicating branches. The stomach contents are gelatinous and brownish due to acid haematin formation. Sometimes, the whole stomach will become corroded. The intestines usually escape, but upper part of the duodenum may be affected. The kidneys are swollen by oedema, congested and the tubules are filled with oxalate crystals. The renal tubles are necrosed, primarily in the proximal convoluted tubules. If the effects are only narcotic, there will be congestion of the lungs, liver, kidneys and brain, without any local appearances.

TEST: A solution of barium nitrate gives a white precipitate of barium oxalate, which is soluble in hydrochloric acid or nitric acid.

The Circumstances of Poisoning: (1) Accidental poisoning is due to its being mistaken for magnesium sulphate, or sodium bicarbonate. (2) Suicidal poisoning is rare. (3) Homicidal poisoning is rare due to sour, acrid taste. (4) Rarely it is used to procure abortion by vaginal injection.

CARBOLIC ACID (phenol; C_6H_4OH)

When pure, the acid consists of short, colourless, prismatic, needle-like crystals, which have a burning sweetish taste, which turn pink and liquefy when exposed to air. It has a characteristic 'carbolic' or phenolic smell. It is slightly soluble in water but is freely soluble in glycerine, ether, alcohol and benzene. The commercial carbolic acid is a dark brown liquid containing several impurities, chiefly cresol. It is largely used as an antiseptic and as a disinfectant. Lysol is a 50% solution of cresol in saponified vegetable oil. Phenol is about eight times more toxic than lysol. Dettol is a chlorinated phenol with turpineol. Important derivatives of phenol include cresol, creosote (coal tar), thymol, menthol and tannic acid.

Absorption: It is readily absorbed from the alimentary tract, respiratory tract, rectum, vagina, serous cavities, wounds and through the skin.

Excretion: Phenol is converted into hydroquinone and pyrocatechol in the body before being excreted in the urine. A trace is excreted by the lungs, salivary glands, skin and stomach. About 36 hours are required for complete excretion. It is partly detoxicated by liver.

Fatal Dose: 10 to 15 g.

Fatal Period: Three to four hours.

Signs and Symptoms: Poisoning by carbolic acid is known as **carbolism.**

Local: (1) Skin: It causes burning and numbness due to damage to nerve endings. It precipitates protein and coagulates the cell contents. Superficial burn is pale grey but deep burns are black. It produces a white opaque eschar which is painless and falls off in a few days and leaves a brown stain. There may be necrosis and gangrene of the tissue which becomes green-white or brown-white; the dead tissue sloughs readily. Lysol discolours the tissues a brownish-purple.

(2) Digestive Tract: Hot burning pain extends from the mouth to the stomach, which is followed by tingling and later anaesthesia. Deglutition and speech become painful and difficult. The lips, mouth and tongue are corroded, which soon become white and hardened. Nausea and vomiting are present in about 20% of cases.

(3) Respiratory Tract: Pulmonary and laryngeal oedema develop due to irritation. Breathing is slow and laboured, progressing to respiratory failure. When vomiting occurs, the poison may be aspirated into the lungs, causing bronchitis and bronchopneumonia.

Systemic Effects: Phenol is a depressant of the nervous system, especially the respiratory centre. Headache, giddiness, unconsciousness and coma occur. The temperature is subnormal, the pupils are contracted, breathing is stertorous, pulse is rapid, feeble and irregular, face covered with cold sweat, and there is dusky cyanosis, respiratory alkalosis and metabolic acidosis. Liver may be damaged. In severe cases haemolysis and methaemoglobinaemia is a characteristic feature. There is a strong odour of phenol in breath. Convulsions and lock-jaw sometimes occur.

Urine: It is scanty and contains albumin and free haemoglobin; suppression may follow. It may be colourless or slightly green at first, but turns green or even black on exposure to air. In the body, phenol is partly oxidised to hydroquinone and pyrocatechol, which with unchanged phenol are excreted in the urine, partly free, and partly in unstable combination with sulphuric and glucoronic acids. The further oxidation of hydroquinone and pyrocatechol in the urine is the cause of green colouration. This is known as **carboluria**.

Chronic poisoning (phenol marasmus) is characterised by anorexia, weight loss, headache, vertigo, dark urine and pigmentation of skin and sclera (oochronosis). The hydroquinone and pyrocatechol may cause pigmentation in the cornea and various cartilages, a condition called **oochronosis.** Oochronosis is commonly associated with alkaptonuria (an inborn error of metabolism), in which homegentisic acid gets deposited in cartilages, ligaments and fibrous tissues.

Cause of Death: (1) Syncope. (2) Asphyxia due to (a) failure of respiration, (b) oedema of glottis, (c) complications, e.g., bronchopneumonia.

Treatment: (1) An emetic often fails due to the anaesthetic effect. (2) The stomach should be washed carefully with plenty of lukewarm water containing activated charcoal, olive oil, castor oil, magnesium or sodium sulphate, or saccharated lime with which phenol combines and forms harmless products. Soap solution or 10% glycerine may be used and the washing continued until the washings are clear and odourless. (3) When lavage is completed 30 g. of magnesium sulphate or a quantity of medicinal liquid paraffin should be left in the stomach. (4) Demulcents. (5) Saline containing seven g. of sodium bicarbonate per litre is given i.v. to combat circulatory depression, to dilute carbolic acid content of blood and to encourage excretion by producing diuresis. (6) Haemodialysis, if there is renal failure. (7) Methylene blue i.v., if there is severe methaemoglobinaemia. (8) If phenol falls on the body, contaminated clothing should be removed at once, skin cleaned, and the area washed with soap and water. Olive oil, or methylated spirit or ten percent solution of ethyl alcohol act as solvents.

Post-mortem Appearances: External: Corrosion of the skin, especially in tracks from the angles of the mouth on to chin, has a greyish or brown colour. The tongue is usually white and swollen, and there is smell of phenol about the mouth. The mucous membrane of the lips, mouth and throat is corrugated, sodden, whitened or ash-grey and partially detached with numerous small submucous haemorrhages.

Internal: The mucosa of the oesophagus is tough, white or grey, corrugated and arranged in longitudinal folds. The stomach mucosal folds are swollen and covered by opaque, coagulated, grey or brown mucous membrane. The intervening furrows are usually less damaged, dark red and are not opaque. The mucous membrane is thickened and looks leathery. Often there is partial separation of

necrotic mucosa, with severe congestion of underlying tissue. The stomach may contain a reddish fluid mixed with mucus and shreds of epithelium and smells of phenol. The duodenum and upper part of the small intestine may show similar but milder changes. The liver and spleen usually show a whitish, hardened patch where the stomach has been in contact with them due to the transudation of phenol. The kidneys show haemorrhagic nephritis in cases of delayed death. The brain is congested, may be oedematous. The blood is dark and semifluid or only partially coagulated. If vomit or poison has been inhaled, coagulation necrosis of the mucosa and severe congestion of the submucosa of the air-passages may be seen. Laryngeal and pulmonary oedema also occur.

TEST: Add a few drops of 10% ferric chloride solution to one ml. of urine. A bluish colour will develop. Salicylates also give positive results.

The Circumstances of Poisoning: (1) It is used for suicidal purposes. (2) Accidental poisoning. (3) It is rarely used for homicide because of its odour and taste. (4) It is sometimes injected into the vagina and uterus to produe abortion. (5) Its indiscriminate medical use sometimes causes poisoning.

FORMIC ACID: It is a colourless liquid with a pungent, penetrating odour. It is used in electroplating, tanning, rubber, textile and paper industry, air-plane glue, stain remover, etc.

ACTION: It has a corrosive acion (coagulation necrosis) on G.I. mucosa. It causes haemolysis leading to acute renal failure. ATP synthesis is diminished.

FATAL DOSE: 50 to 200 ml.

SIGNS AND SYMPTOMS:G.I.T.: Burning pain, salivation, vomiting, mucosal ulceration and corrosion, haematemesis, R.S: Acute respiratory distress. C.V.S: Tachycardia or bradycardia, hypertension or hypotension. BLOOD: Haemolysis. C.N.S: Drowsiness, coma, dilated pupils. SKIN: Blisters. Metabolic acidosis, shock and death.

TRATMENT: (1) Milk is given for dilution of acid. (2) Gastric lavage and emetics are contraindicated. (3) Folinic acid 1mg/kg i.v. at 4 hourly intervals for 6 doses. (4) Dialysis or exchange transfusion.

POST-MORTEM APPEARANCES: Corrosion and blackening of gastric mucosa and pulmonary oedema.

Poisoning is suicidal or accidental.

CAUSTIC ALKALIS: The chief poisons are ammonia, potassium hydroxide, sodium hydroxide, calcium hydroxide, ammonium carbonate, potassium carbonate and sodium carbonate. They are extensively used in commerce. Most of these occur as white powders. Ammonia is a colourless gas with a very pungent, choking odour. Ammonium hydroxide is a liquid containing about 30% ammonia. Household bleaches commonly consist of 5% sodium hypochlorite solutions and cause moderate mucosal irritation.

Action: They are the commonest cause of chemical burns. The hydroxyl ion produces a saponification of fat, soluble alkaline proteinases, cellular dehydration and an exothermic reaction. The ion passes from molecule to molecule, denaturing each in turn, and burrows deeply, producing soft gelatinous, friable eschars (liquefaction necrosis). Ingestion of an alkali produces severe effects mainly on lining of oesophagus, while gastric involvement is less common. Therefore, stricture formation is much more common with alkalis than with acids.

Signs and Symptoms: In general, the lesions caused by caustic alkalis have about the same extent and distribution as those due to acid corrosives. There is an acid caustic taste and a sensation of burning heat extending from the throat to the stomach. Vomited matters are alkaline and do not effervesce on contact with the ground. It is at first thick and slimy, but later contains dark altered blood and shreds of mucosa. Purging is a frequent symptom, accompanied by severe pain and straining. The motions consist of mucus and blood.

Contact with skin causes greyish, soapy, necrotic area. When strong alkali is ingested, abrasions, blisters and brownish discolouration are seen on the lips and the skin about the mouth. The mucosa of the digestive tract is swollen, soft and a grey slough readily detached, lies over the inflamed tissues. Haemorrhage into the tissue is also seen. Oesophageal stricture formation is a major long-term complication.

LYE (NaOH): It can produce transmural necrosis of the oesophagus after only one second of contact. Oesophageal stricture is common with occasional perforation.

MINIATURE (BUTTON) BATTERIES: They contain potassium hydroxide, which when swallowed can cause liquefaction necrosis following leakage from battery. Symptoms are mostly limited to GI tract.

Ammoniacal vapour when inhaled causes congestion and watering of the eyes, violent sneezing, coughing and choking. Sudden collapse and death may occur from suffocation due to inflammation and much swelling of the glottis or later from pneumonia.

Fatal Dose:
Potassium or sodium hydroxide 5 g.
Potassium carbonate 18 g.
Sodium carbonate 30 g.
Ammonia 5 to 10 ml.

Fatal Period: Usually 24 hours.

Treatment: (1) Demulcents, e.g. white of egg, or milk, or water 1 to 2 glasses may be given if the patient is seen within 5 to 10 minutes of ingestion. (2) In mild cases the stomach can be washed carefully. (3) In poisoning by ammonia vapour, oxygen inhalation should be given or the patient should be kept in an atmosphere made moist with steam. (4) Keep the airway patent. Tracheostomy may be necessary. (5) Give adequate parenteral analgesics. (6) Steroids are useful in decreasing laryngeal inflammation. (7) Antibiotics to prevent infection.

Post-mortem Appearances: The marks about the mouth become dark in colour and parchment-like after death. When a strong alkali is ingested, lips, mouth and throat show corrosion. Inflammatory oedema with corrosion and sliminess of the tissues of the oesophagus and stomach are prominent features. Alkalis most severely affect the squamous epithelium of the oesophagus, although stomach is involved in 20% cases. Mucosa may be brownish due to formation of alkali haematin. The duodenum and jejunum may show similar changes but of lesser intensity. In some cases, the alkali may be regurgitated and inhaled causing oedema of the glottis, pseudomembranous inflammation of the air-passages and a peribronchial pneumonia. Perforation of the oesophagus or stomach is rare but may occur in ammonia poisoning. Oesophageal stricture formation is common with alkalis than acids.

TEST: The caustic alkalis produce a brown precipitate with silver nitrate. The caustic carbonates produce a whitish-yellow precipitate and effervesce if an acid is added.

CIRCUMSTANCES OF POISONING: Poisoning by alkalis is rare. Accidental cases occur due to its being mistaken for medicine. Homicidal poisoning is rare, but few suicidal cases are seen. Sometimes, a solution of caustic soda is thrown with evil intention on the face and body of an enemy. Poisoning by ammonia is more common than other alkalis.

CHEMICAL BURNS: In chemical burns, the amount of tissue damaged depends upon the agent, its strength and concentration, the quantity of the chemical, the duration of contact, and the extent of penetration of the body by the chemical. Chemicals continue to act on tissue until they are either neutralised by another agent or inactivated by the tissue reaction. Strong acids have a pH of less than 2. Alkalis injure the tissue if the pH is 11.5 or more. Alkalis produce more severe injury than acids, because they dissolve protein and saponify fat. They produce a liquefaction necrosis permitting deeper invasion of tissue with deep burns and marked oedema. Alkalis produce a soft, oedematous, translucent, soap-like, swollen eschar, red-brown from the absorption of altered blood pigment. The sloughs are mucilaginous. Charring is not seen.

Acids precipitate proteins, producing a coagulation necrosis with a hard eschar. Acids cause more damage to the stomach than the oesophagus. The burns are clearly demarcated, dry and hard. Oedema is mild. The burns are usually of second degree, but if contact is prolonged, third degree burns are caused, especially from concentrated sulphuric or nitric acid, and the scab is dark, leathery and dry. Hydrofluoric acid causes much deeper burns.

Prolonged contact with cement (pH 12.5 to 14) can produce chemical burns. Prolonged contact with hydrocarbons, such as gasoline, can cause chemical burns due to their irritant effect and their high lipid solubility. Chemical burns are also produced by phosphorus and phenol.

CHAPTER 27
METALLIC POISONS

ARSENIC

Metallic arsenic (black coloured) is not poisonous, as it is not absorbed from the alimentary canal. When volatilised by heat, arsenic unites with oxygen and forms poisonous vapour of arsenic trioxide.

Poisonous Compounds : (1) **Arsenious oxide or Arsenic trioxide** *(sankhya or somalkhar).* This is the most common form of arsenic used, and is known as white arsenic or arsenic. It occurs in two forms : (a) white, smooth, heavy, crystalline powder, (b) white and opaque solid mass similar to procelain. It has no taste or smell and is sparingly soluble in water. When the powder is added to water it floats on the surface, though it is three-and-half times heavier than water. It sublimes on heating. Arsenic is used in fruit sprays, sheep-dips, weed-killers, insecticides, rat poisons, fly papers, calico-printing, taxidermy, wall papers and artificial flowers, as mordant in dyeing and for preserving timber and skin against white ants. (2) Copper arsenite (Scheele's green) and copper acetoarsenite (Paris green or emerald green). (3)Arsenic acid. (4) Sodium and potassium arsenate. (5) Arsenic sulphide, orpiment and realgar. (6) Arsenic trichloride (butter of arsenic). (7) Arseniuretted hydrogen or arsine is a colourless gas with garlic-like, non-irritating odour. (8) Organic compounds, e.g., cacodylates, atoxyl, acetarson, tryparsamide, salvarsan, mepharsen, etc.

Action : Arsenic interferes with cellular respiration by combining with the sulphydryl groups of mitochondrial enzymes, especially pyruvate oxidase, and certain phosphatases. Its particular target is vascular endothelium, leading to increased permeability, tissue oedema and haemorrhage, especially in the intestinal canal. Locally it causes irritation of the mucous membranes and remotely depression of the nervous system. Arsenate causes its toxicity by uncoupling mitochondrial oxidative phosphorylation. It interferes with glycolysis.

Signs and Symptoms : (1) The Fulminant Type : Massive doses (3 to 5 gm) of arsenic when rapidly absorbed cause death in one to 3 hours from shock and peripheral vascular failure. All the capillaries are markedly dilated, especially in the splanchnic area with a marked fall of blood pressure. Arsenic also has a direct action on heart muscle. In this type gastrointestinal symptoms are absent.

(2) The Gastroenteric Type : This is the common form of acute poisoning, and resembles bacterial food poisoning. Symptoms usually appear half to one hour after ingestion, but may be delayed many hours especially when arsenic is taken with food. There is sweetish metallic taste. **G.I.T.:** Constriction in the throat and difficulty in swallowing; burning and colicky pain in oesophagus, stomach and bowel occur. Intense thirst and severe vomiting which may be projectile are the constant symptoms. Purging is usually accompanied by tenesmus, pain, and irritation about the anus. The stools are expelled frequently and involuntarily, and are dark-coloured, stinking and bloody, but later become colourless, odourless and watery resembling rice-water stools of cholera. **Hepatic:** Fatty infiltration. **Renal:** Oliguria, uraemia; urine contains albumen, red cells and casts, pain during micturition. **C.V.S.:** Acute circulatory collapse with vasodilation, increased vascular permeability, ventricular tachycardia, ventricular fibrillation. **CNS:** Headache, vertigo, hyperthermia, tremors, convulsions, coma, general paralysis. **Skin:** Delayed loss of hair, skin eruptions.

Narcotic Form : In this form, the gastrointestinal symptoms are very slight. There is giddiness, formication and tenderness of the muscles, delirium, coma and death. Rarely there is complete paralysis of the extremities.

Arseniuretted hydrogen, when inhaled acts as a direct poison to the haemoglobin, producing haemolysis, haemoglobinuria and renal failure. Death is almost instantaneous.

Fatal Dose : 0.1 to 0.2 g. arsenic trioxide.

Fatal Period : One to two days.

Treatment : (1) Emetics are not recommended. (2) The stomach should be emptied and then thoroughly and repeatedly washed by the stomach tube with large amount of warm water and milk. The stomach should be washed out at intervals to remove iron compounds, and adherent arsenic. (2) Butter and greasy substances prevent absorption. (3) Alkalis should not be given as they increase the solubility of arsenic. (4) Freshly precipitated, hydrated ferric oxide orally in small doses converts toxic arsenic to non-toxic ferric oxide. (5) B.A.L. 400 to 800 mg on first day, 200 to 400 mg on second and

Table (27–1) Difference between arsenic poisoning and cholera

Trait	Arsenic poisoning	Cholera
(1) Pain in throat :	Before vomiting.	After vomiting.
(2) Purging :	After vomiting.	Before vomiting.
(3) Stools:	Dark-coloured and bloody, later rice-watery.	Rice-watery, not bloody and passed in continuous involuntary jet.
(4) Tenesmus and anal irritation :	Present.	Absent.
(5) Vomited matter :	Contains mucus, bile and blood.	Watery without mucus, bile and blood.
(6) Voice:	Not affected.	Rough and whistling.
(7) Conjunctivae :	Inflamed.	Not inflamed.
(8) Analysis of excreta :	Arsenic present.	Cholera vibrio present.
(9) Circumstantial evidence :	Of arsenic poisoning may be present.	Other cases of cholera in locality.

third days, in divided doses every four hours and 100 to 200 mg. in two divided doses for 7 to 10 days or until urine level falls below 50 μg in a 24 hour specimen. (6) Penicillamine may be used with BAL. 100 mg/kg daily upto 1 to 2 g. in four divided doses for five days. (7) DMSA (succimer) or DMPS can be used instead of BAL if available. It is superior to BAL. (8) Demulcents lessen irritation. (9) Castor oil or magnesium sulphate to prevent intestinal absorption of arsenic. (10) Glucose-saline with sodium bicarbonate is helpful to combat shock and improve alkali reserve. (11) Haemodialysis or exchange transfusion may be given if necessary. (12) Chelation therapy is ineffective in arsine poisoning.

Post-mortem Appearances : External : The eyeballs are sunken and the skin is cyanosed. The body may be shrunken due to dehydration.

Internal : The mouth, pharynx and oesophagus is usually not affected, but in some cases is inflamed or ulcerated. The lesions are mainly found in the stomach. The mucosa is swollen, oedematous and red either generally or in patches, especially in the pyloric region. There may be lines of redness running along the walls or curved lines of submucous haemorrhages. Usually groups of petechiae are seen scattered over the mucosa and sometimes large submucosal and subperitoneal haemorrhages. The stomach mucosa resembles red velvet. Small acute ulcerations or large erosions may be found, especially at the pyloric end. A mass of sticky mucus covers the mucosa in which particles of arsenic may be seen. Congestion is most marked along the crest of the rugae. Inflammation is more marked at the greater curvature and posterior part and the cardiac end of the stomach. The small intestine appears flaccid and contains large flakes of mucus with very little faecal matter. The mucosa is pale-violet and shows signs of inflammation with submucous haemorrhages along its whole length. The caecum and rectum show slight inflammation. Sometimes, arsenic penetrates through the walls of the stomach and appears in liver, omentum and endocardium. If putrefaction has taken place, yellow streaks will be found in the subperitoneal layer of the stomach and to less extent of the intestines, due to absorbed arsenic which has been converted into sulphide. In fulminating type, the stomach and intestines may not show any signs of inflammation. The liver, spleen and kidneys are congested, enlarged and show cloudy swelling and occasionally fatty change. The lungs are congested with subpleural ecchymoses. Nephritis, particularly of golmerular type is frequent. Haemorrhages may be found in the abdominal organs, mesenteries and occasionally in larynx, trachea and lungs. There may be oedema of brain with patchy necrosis or haemorrhagic encephalitis. The meninges are congested. Subendocardial petechial haemorrhages of the ventricle are common in arsenic poisoning and may be found even when the stomach shows little sign of irritation. It is typical of arsenic poisoning, although they are sometimes found in poisoning by phosphorus, barium and mercury, and in cases of heat stroke and in acute infectious disease, e.g. influenza or in traumatic asphyxia. In a few days fatty deposits occur in the heart, liver and kidneys, and kidneys show acute tubular necrosis. In death due to acute arsenic poisoning, arsenic values in the liver and blood in excess of one mg. % are usually present. X-ray may show presence of arsenic in G.I. tract.

Chronic Poisoning : It may be due to accidental

ingestion of repeated small doses by those working with the metal, or by taking food or drink in which there are traces of drug. It may be of homicidal nature due to repeated small doses, or may occur after recovery from one large dose.

C.N.S. : Polyneuritis, anaesthesias, paraesthesia, encephalopathy. **Skin** : Pigmentation consists of a finely mottled brown change mostly on the skin flexures, temples, eyelids and neck **(raindrop type of pigmentation),** which persists for many months. There may be a rash resembling fading measles rash. In prolonged contact, hyperkeratosis of the palms and soles with irregular thickening of the nails and development of bands of opacity in the fingernails called **Aldrich-Mees lines** is seen. **Eyes :** Congestion, watering of the eyes, photophobia. **G.I.T. :** Nausea, vomiting, abdominal cramps, diarrhoea, salivation. **C.V.S. and kidneys** : Chronic nephritis, cardiac failure, dependent oedema. **Hepatic:** Hepatomegaly, jaundice, cirrhosis of the liver. **Haematologic:** Bone marrow suppression, hypoplasia, anaemia, thrombocytopaenia, leukaemia. **General :** Anaemia and weight loss. **R.S.:** Cough, haemoptysis, dyspnoea.

Arsenic is teratogenic and can result in lung and skin cancer, leukaemia, etc.,

Post-mortem Appearances : The stomach may be normal or may show a chronic gastritis. Some rugae may show patchy inflammatory redness. In some cases, patchy haemorrhagic gastritis with acute and chronic erosions are seen. The small intestine is dilated, reddened , with thickened mucosa. The liver may be fatty or there may be severe necrosis. There may be jaundice. The kidneys show tubular necrosis.

Treatment consists in removing the patient from the source of exposure and administration of B.A.L.

Organic Arsenical Compounds : They contain arsenic either in trivalent or pentavalent combination. They are less toxic than inorganic compounds. Their chief toxic manifestations are immediate anaphylactic symptoms and later on skin reactions, agranulocytosis, hepatitis, jaundice and encephalitis.

Absorption : The average daily human intake of arsenic is half to one mg. contained in food and water. It is absorbed orally (pentavalent arsenic), dermally (arsenite), by inhalation (arsine), or parenterally. On absorption, it is bound to the protein portion of haemoglobin. Permissible limits of arsenic in ground water is 0.05 mg/litre.

Distribution : Arsenic is normally present in almost all tissues. In the early stage, arsenic is found in greatest quantity in the liver, followed by kidneys and spleen. Arsenic does not cross blood-brain barrier well (brain has lowest level), but inorganic arsenic can cross the placenta. In cases in which life is prolonged, it is found in the muscles for days, in the bones and in the keratin tissues, hair, nails and skin for years. It replaces phosphorus in the bone where it may remain for years. Normally hair contains less than two parts per million arsenic. It can appear in hair and nails within hours of ingestion. In fatal cases, the concentration of arsenic in the liver is usually one mg % or more. Neutron activation analysis and atomic absorption spectroscopy helps in estimating concentration of arsenic in hair, nails, bone, etc.

Elimination : It is eliminated mainly by the kidneys, in the form of methylated arsenic, but also in the faeces, bile, sweat, milk and other secretions. Breast milk does not contain significant amounts of arsenic. It may be found in the urine within half-an-hour of ingestion and excretion by urine is fairly continuous for about 10 to 12 days. In acute poisoning 24 hour excretion in urine is more than 100 mg. The arsenic is excreted into the epidermal tissues, such as hair and nails within hours of ingestion, and in cases of intermittent chronic poisoning, there will be successive deposits of arsenic in the hair and nails. The excretion of arsenic in a healthy person taking food rich in fish, especially shellfish, can be more than that seen in chronic poisoning. Arsenic is excreted into the stomach and intestines after absorption, even when given by routes other than mouth. It becomes fixed in cancellous tissues or bones, chiefly long bones.

Tolerance : Some people take arsenic daily as a tonic or as an aphrodisiac, and they acquire tolerance up to 0.3 g. or more in one dose. Such people are known as **arsenophagists.**

TESTS : 1) Excretion of more than 100 µg in 24 hours urine. (2) Detection by atomic absorption spectroscopy. Marsh's test and Reinsch's tests are absolete.

The Circumstances of Poisoning :

(1) Homicide : Arsenic is popular homicidal poison because : (1) it is cheap, (2) easily obtained, (3) colourless, (4) no smell, (5) no taste, (6) small quantity is required to cause death, (7) can be easily administered with food or drink, (8) onset of symptoms is gradual, (9) symptoms simulate those of cholera. The **disadvantages** are : (1) it delays

putrefaction, (2) can be detected in completely decomposed bodies, (3) can be found in bones, hair and nails for several years, (4) can be detected in charred bones or ashes.

For homicide, it is given orally mixed with some articles of food like sweets, bread, milk, tea, cold drinks, etc. Mass homicidal poisoning occurs when it is mixed with food or in a well. Sometimes it is given mixed with tobacco or cigars for homicide or to rob. (2) Suicide is rare because it causes much pain. (3) Accidental death may be due to admixture with articles of food, or from its improper medicinal use. Chronic poisoning results from drinking well water containing arsenic. (4) It is sometimes ingested or applied locally in the form of a paste or ointment to abortion sticks to produce abortion. (5) It is fed to the animal mixed with cattle fodder.

Post-mortem Imbibition of Arsenic : In exhumations, the possibility of imbibition of arsenic from the stomach into neighbouring viscera and also contamination from the surrounding earth should be remembered. Arsenic found in the soil is usually an insoluble salt. Keratin tissues absorb arsenic by contamination from outside. The concentration in hair and nails thus contaminated is likely to be much greater than the concentration of arsenic in the contaminating fluid. If arsenic is introduced into the stomach after death, the transudation occurs into the organs of the left side before those of the right and the signs of inflammation and ulceration are absent.

MERCURY (QUICK SILVER)

It is liquid metal, bright silvery appearance and is volatile at room temperature. It forms two series of compounds : (1) mercuric, which are soluble and intensely poisonous ; and (2) mercurous, which are much less soluble and therefore less active. Metallic mercury is not poisonous if swallowed, for it is not absorbed. If the mercury is breathed or swallowed as vapour, or if applied to the skin or mucous membrane in finely divided state it is absorbed.

Action: The mercuric ion binds with sulphydryl groups of enzymes and cellular proteins, nucleic acids and mitotic apparatus interfering with enzyme and cellular transport functions. It is rapidly converted to mercuric ions in the blood which can lead to renal tubular damage. In the CNS, mercury acts mainly upon cerebellum, temporal lobe, basal ganglia and corpus callosum.

Acute exposure to elemental mercury vapour may produce corrosive bronchitis with fever, chills and dyspnoea. It may progress to pulmonary oedema and fibrosis. Sometimes manifestations similar to Kawasaki disease (mucocutaneous lymph node syndrome) are seen especially in children.

Poisonous Compounds : (1) Mercuric chloride ($HgCl_2$; corrosive sublimate), occurs as colourless masses of prismatic crystals, or as a white crystalline powder. It has no smell, but a styptic, nauseous, metallic taste. (2) Mercuric oxide (brick-red crystalline powder). (3) Mercuric iodide (scarlet-red powder). (4) Mercuric cyanide (white prismatic crystals). (5) Mercuric sulphide (cinnabar, sindoor). Artificial preparation occurs as red crystalline powder and is known as vermilion. (6) Mercurous chloride (calomel). (7) Mercuric nitrite. (8) Mercuric sulphate (white crystalline powder). (9) Sulphate of mercury (lemon-yellow powder). (10) Ammoniomercuric chloride. (11) Organic compounds of mercury.

Symptoms : First Phase : Acrid metallic taste and feeling of constriction in the throat, hoarse voice, difficulty in breathing. The mouth, tongue and fauces become corroded, swollen and show a greyish-white coating. Hot burning pain in the mouth, extending down to the stomach and abdomen, followed by nausea, retching and vomiting. The vomit contains greyish slimy mucoid material with blood and shreds of mucous membrane. This is followed by diarrhoea with bloodstained stools and tenesmus. Circulatory collapse occurs soon. Inhalation of fumes produce nervous symptoms, e.g. ataxia, restriction of visual field, paresis and delirium.

Second Phase : If the person survives, second phase begins in one to 3 days. Glossitis and ulcerative gingivitis appear within 24 to 36 hours. Severe infection, loosening of teeth and necrosis of the jaw may occur. In 2 to 3 days, renal tubules show necrosis and produce transient polyuria, albuminuria, cylindruria, uraemia and acidosis. Recovery may occur within 10 to 14 days. After many days membranous colitis develops and produces dysentery, ulceration of colonic mucosa and haemorrhage.

Intramuscular injection produces abscess with ulceration. I.V. injection may cause mercurialism in which thrombophlebitis, granuloma formation, pulmonary embolism and repeated haemoptysis is seen.

Organic mercurials, such as phenyl and methoxymethyl mercury, ethyl and methyl mercury

are more toxic. Symptoms are mainly CNS and include ataxia, dysarthria, paraesthesias, neuropathies, mental deterioration and chorea.

Fatal Dose : One to 2 g. of mercuric chloride.

Fatal Period : Three to five days.

Treatment : (1) Give egg-whites, milk or activated charcoal to precipitate mercury. Gastric lavage with egg-white solution or two to five percent solution of sodium bicarbonate is of uncertain benefit. (3) Activated charcoal or 5% sodium formaldehyde sulphoxylate solution is done to bind the mercury. (4) BAL is the chelating agent of choice. Dosage regimen is same as for arsenic. (5) Penicillamine is an alternative given orally in 4 divided doses of 100 mg/kg/day for 3 to 7 days, repeated after 10 days if necessary. (6) Ca-EDTA should not be used, as it is nephrotoxic with mercury. (7) Urine must be kept alkaline. (8) High colonic lavage with 1 : 1000 solution of sulphoxylate twice daily. (9) Haemodialysis is indicated if there is significant kidney damage.

Post-mortem Appearances : The mucosa of the gastrointestinal tract shows inflammation, congestion, coagulation and corrosion. If the person survives for few days, the large intestine shows necrosis due to the re-excretion of mercury into the large bowel. Acute tubular and glomerular degeneration or haemorrhagic glomerular nephritis is seen. The liver is congested and shows cloudy swelling or fatty change.

Chronic Poisoning (Hydrargyrism): This may result from (1) continuous accidental absorption by the workers, (2) excessive therapeutic use, (3) from recovery from a large dose, and (4) if ointment is used as external application for a long time. Chronic exposure to elemental mercury yields a classic triad of gingivitis and salivation, tremors and neuropsychiatric changes. The symptoms are salivation, inflammation of gums and occasionally a blue line at their junction with teeth, sore mouth and throat, loosening of teeth, gastrointestinal disturbances, anaemia, anorexia, loss of weight and chronic inflammation of kidneys with progressive uraemia. Tremors (sometimes called **Danbury tremors)** occur first in the hands, then progress to lips and tongue and finally involves arms and legs. The tremor is moderately coarse and is interspersed by jerky movements. The advanced condition is called **hatter's shakes or glass-blower's shakes,** because they are common in persons working in glass-blowing and hat industries. The patient then becomes unable to dress himself. write legibly or walk properly. The most severe form is known as **concussio mercurialis,** in which no activity is possible. **Mercurial erethism** is seen in persons working with mercury in mirror manufacturing firms. This term is used to refer to the psychological effects of mercury toxicity. These include anxiety, depression, shyness, timidity, irritability, loss of confidence, mental depression, delusions and hallucinations, or suicidal melancholia, or manic depressive psychosis (mad hatter), emotional instability, loss of memory and insomnia. **Mercurialentis** is a peculiar eye change due to exposure to the vapour of mercury. It is due to brownish deposit of mercury through the cornea on the anterior lens capsule. Slit-lamp examination demonstrates a malt-brown reflex from the anterior lens capsule. It is bilateral and has no effect on visual acuity. Renal damage results in membranous glamerulonephritis with hyaline casts and fatty casts in the urine. Kidney is the primary target.

Acrodynia or pink disease (because it is characterised by a generalised body rash) is thought to be an idiosyncratic hypersensitivity reaction particularly seen in children. This can be caused by chronic mercury exposure in any form usually in children. The onset is insidious with anorexia, insomnia, sweating, skin rash and photophobia. Hands and feet become puffy, pinkish, painful, paraesthetic with peeling of skin. Teeth may be shed.

Treatment : (1) Removal of patient from further exposure. (2) Demulcents. (3) Saline purgatives. (4) Oral hygiene. (5) Chelation therapy: D-pencillamine 25 to 40 mg/kg/day (maximum 1g) for children in two divided doses and 250 mg 4 times a day for adults is given until urine mercury levels are less than 5 μg/L OR BAL 100 mg i.m. 4th hourly for 2 days, followed by 100 mg every 8 hours for 8 to 10 days, OR DMPS 5 mg/kg i.v. or 6 infusions of 250 mg/day, followed by 100 mg orally twice a day for 24 days OR DMSA 30 mg/kg/day orally for 5 days, followed by 20 mg/day for 14 days. (6) For organic mercurials chelation is not very effective.

Minimata disease is a type of organic mercurial poisoning due to eating of fish poisoned by mercury.

Fate and Excretion : After absorption, the mercuric ion is distributed between blood cells and

plasma. It then diffuses into the tissues where it rapidly binds to most protein sulphydryl groups. Mercury is impounded in all tissues, particularly in liver, kidneys, spleen and bones. Excretion is by kidneys, liver and colonic mucous membrane. It is also excreted in the saliva, milk, sweat and faeces, if the quantity is larger. It passes rapidly to the foetus in utero through the placental circulation. It is not a constituent of the human body. Normal blood mercury level is less than 4 μg/100ml.

TEST : If a piece of copper wire is introduced in the solution and a few drops of hydrochloric acid are added, a silver coating of mercury will be formed on the wire.

The Circumstances of Poisoning : Accidental poisoning by mercuric chloride may be due to the use of strong solution in washing abscess cavities or irrigating the vagina, uterus or rectum. Sometimes, it is introduced into the vagina as a contraceptive or for producing abortion. Homicidal and suicidal poisoning is rare.

LEAD

It is a heavy steel-grey metal. Metallic lead and all its salts are poisonous. The principal salts which produce toxic effects are: (1) Lead acetate (sugar of lead); white crystals. (2) Lead carbonate (*safeda*): a white crystalline powder. (3) Lead chromate : a bright yellow powder. (4) Lead monoxide (litharge); pale brick-red or pale orange masses. (5) Lead tetroxide (red lead, vermilion, *sindur*); scarlet crystalline powder. (6) Lead sulphide is least toxic. Lead is used in storage batteries, solders, paints, hair dyes, electric cable insulations, pottery and ceramics and petrols.

ACUTE POISONING : The symptoms are : an astringent and metallic taste, dry throat, thirst, burning abdominal pain, nausea, vomiting, sometimes diarrhoea, peripheral circulatory collapse, headache, insomnia, paraesthesias, depression, coma and death.

Cerebellar ataxia is common in children in acute lead poisoning.

ACTION: At the cellular level, lead interacts with sulphydryl groups and interferes with the action of enzymes necessary for haem synthesis, and for haemoglobin and cytochrome production. It causes haemolysis.

FATAL DOSE : About 20 g. lead acetate; 40 g. lead carbonate.

FATAL PERIOD : One to two days.

LABORATORY FINDINGS : Porphyrinuria, mainly due to coproporphyrin III, is a valuable screening test. In the blood, levels above 0.07 mg%, and in the urine 0.15 to 0.3 mg. per litre is diagnostic.

TREATMENT : (1) Gastric lavage with one% solution of sodium or magnesium sulphate. (2) Demulcents. (3) The combination of B.A.L. and calcium disodium versenate or DMSA is effective. (4) Penicillamine. (5) Calcium chloride 5 mg. of a 10% solution i.v. causes deposition of lead in the skeleton from the blood. (6) Peritoneal or haemodialysis. (7) Symptomatic treatment.

POST-MORTEM APPEARANCES : Signs of acute gastroenteritis are seen. The mucosa of the stomach may by thickened and softened with eroded patches and may be covered with a greyish-white deposit.

Chronic Poisoning (plumbism; saturnism): Causes : (1) Inhalation of lead dust and fumes by makers of white lead and makers and users of lead paints, smelters, plumbers, glass-polishers, printers, enamel workers, glass blowers, etc. (2) Continuous absorption of minute amounts from drinking water stored in lead cisterns, from tinned food contaminated with lead from the solder, and from constant use of hair dyes and cosmetics containing lead. (3) Absorption through raw or intact skin. (4) Use of *ghee* stored in brass or copper vessels lined inside with tin in which oleate of lead is formed and also by taking food cooked in tinned vessel. (5) Absorption of vermilion applied to the scalp. (6) Children can be chronically poisoned through chewing or licking toys, walls, furniture, etc. painted with lead based compounds. Chronic poisoning results from a daily intake of one to two mg. of lead. Lead vapour is more dangerous than dust. Lead is a typical cumulative poison.

Signs and Symptoms : (1) Facial Pallor : The facial pallor particularly about the mouth is one of the earliest and most consistent sign. It seems to be due to vasospasm.

(2) Anaemia : There may be polycythaemia with polychromatophilia in early stages, but later there is anaemia which is associated with polychromasia, punctate basophilia, reticulocytosis, poikilocytosis, anisocytosis, nucleated red cells **(sideroblasts)** and an increase in mononuclear cells, whereas polymorphonuclear cells and platelets are decreased. The anaemia is probably due to decreased survival time of red blood cells and inhibition of haeme synthesis by interference with the incorporation of iron into protoporphyrin. **Punctate basophilia** or **basophilic stippling** means the presence of many dark blue-coloured pinhead sized spots in the cytoplasm of red blood cells, due to toxic action of lead on porphyrin metabolism. Reticulocytes and basophilic stippled cells result

from the inhibition of 5 pyrimidine nucleotidase, an impaired ability to rid the cell of RNA degradation products and the aggregation of ribosome. **Eosinophilia** is more common than basophilic stippling. Porphyrins excreted in urine may be 500 micrograms per day.

(3) Lead Line : A stippled blue line, called **Burtonian line,** is seen on the gums in 50 to 70% of cases. It appears due to subepithelial deposit of granules at the junction with teeth, only near dirty or carious teeth, within a week of exposure, especially on upper jaw. It is due to formation of lead sulphide by the action of hydrogen sulphide formed by decomposed food in the mouth. A similar blue line may be seen in cases of poisoning by mercury, copper, bismuth, iron and silver.

(4) Colic and Constipation : It is usually later symptom. Colic of intestines, ureters, uterus and blood vessels occur in 85% of cases. The colic occurs at night and the pain may be very severe. Individual attacks last only a few minutes, but may recur for several days or weeks. Constipation is usual but diarrhoea or vomiting may occur.

(5) Lead Palsy : It usually occurs late, and is seen in less than 10% of cases. There may be tremors, numbness, hyperaesthesia, and cramps before the actual muscle weakness. It is commoner in adults than in children, and men are particularly affected. The muscle groups affected are those most prone to fatigue. Usually the extensor muscles of the wrist (wrist drop; radial nerve is affected) are affected, but the deltoid, biceps, anterior tibial (foot drop), and rarely muscles of eye or intrinsic muscles of hand or foot are affected. The paralysis is associated with degeneration of the nerve and atrophy of the muscles. Recovery may be complete but is usually slow.

(6) Encephalopathy : Lead encephalopathy, in some form is said to be present in almost every case of plumbism. It is common in children often associated with tetraethyl lead. The symptoms are vomiting, headache, insomnia, visual disturbances, irritability, restlessness, delirium, hallucinations, convulsions, coma and death. Lead encephalopathy is usually irreversible and about 85% have permanent brain damage. Death occurs in about 25% cases.

(7) Cardiovascular System and Kidneys : Lead causes vascular constriction, leading to hypertension and permanent arteriolar degeneration. Chronic arteriosclerotic nephritis and interstitial nephritis occur.

(8) Reproductive System : Menstrual derangements, such as amenorrhoea, dysmenorrhoea, menorrhagia, sterility of both sexes, and abortion are frequent. Abortion occurs in pregnant women between 3 to 6 months.

(9) Other Systems : They are dyspepsia, anorexia, emaciation, general weakness, exhaustion, irritability, foul breath, headache, vertigo, loss of hair and drowsiness. Peripheral neuritis is rare.

Retinal stippling is noticed by ophthalmoscopic examination showing presence of greyish glistening lead particles in the early phase of poisoning.

Diagnosis :(1) History. (2) Clinical features. (3) Laboratory tests: (a) Coproporphyrin in urine (CPU): In non-exposed persons it is less than 150 micrograms/litre. (b) Aminolaevulinic acid in urine (ALAU): more than 5 µg. indicates poisoning. (c) Blood lead level more than 25 µg per 100 ml. (d) The presence of 0.25 mg. of lead per litre of urine is also diagnostic. (e) X-ray evidence of increase radio-opaque bands or lines at the metaphyses of long bones is seen in children. (f) Basophilic stippling. (g) Zinc protoporphyrin and free erythrocyte protoporphyrin levels above 50 µg/100 ml indicate poisoning. (h) X-ray may show radio-opaque material, in the G.I. tract if lead is ingested during preceding 36 to 48 hours. (i) Calcium disodium versenate ($CaNa_2$ - EDTA) provocation test is not recommended.

Prophylaxis : To prevent chronic lead poisoning in factory workers, the following measures should be taken. (1) Maintenance of proper ventilation in factories. (2) Maintenance of personal hygiene of the workers and periodical medical examination. (3) A diet rich in calcium. (4) Small amount of sulphuric acid in water. (5) Weekly saline purgative.

Treatment : **(A) Severe acute poisoning with encephalopathy:** (1) BAL 4 mg/kg immediately (in childen). Repeat the same dose at 4 hourly intervals until blood lead levels fall below 40 µg/100 ml. Then reduce BAL to 12 mg/kg/day in 3 divided doses. (2) CaNa2 EDTA 75 mg/kg/day i.v. infusion. Reduce EDTA to 50 mg/kg/day as condition improves. (3) The above regimen is continued until patient is asymptomatic and can tolerate oral chelation with D-penicillamine 10mg/kg/day or DMSA, 10mg/kg/ dose t.i.d. for 20 days.

(B) Severe poisoning without encephalopathy (BL more than 70mg/ 100ml) : (1) BAL 12 mg/kg/day. (2) EDTA 50mg/kg/day. (3) Discontinue

BAL when blood level falls below 40 µg/100 ml. but continue EDTA for 5 more days. (4) Continue oral chelation until the BL falls below 15 µg/100 ml. or for 3 months.

(C) Moderate poisoning (BL between 45 to 75 µg/100ml): (1) EDTA 50 mg/kg/day. (2) When BL level falls below 40 mg/100 ml begin oral chelation.

(D) Mild poisoning (BL 20 to 35 µg/100ml): D-penicillamine 30 mg/kg/day in 3 divided doses. Start with one-fourth of the calculated dose. Double this after one week. Double again after one week. Continue this until BL falls to less than 15 µg/100 ml. or for 3 months.

DMSA (succimer) 10mg/kg/dose t.i.d. for 20 days is more effective and less toxic.

Supportive measures include: (1) Thiamine, 10 to 50 mg/kg to improve neurological manifestations. (2) Calcium gluconate i.v. for colic. (2) Magnesium or sodium sulphate 8 to 12 g. will change unabsorbed lead salts to the highly insoluble lead sulphate and hasten its passage in the stools. (3) Calcium versenate of disodium acts as an ion exchanger in which the calcium is exchanged for the heavy metal ion and a soluble, stable, and unionized chelate of lead is formed. The complex is stable and is a less toxic molecule. The rate of excretion of lead as the EDTA complex in the urine increases fiftyfold above the normal untreated excretion rate. Chelating therapy serves to detoxify the lead, withdraws it from the effector sites and promotes excretion. EDTA 5 ml. of 20% solution is diluted with 250 to 500 ml. of normal saline or 5% glucose, and given by drip method over a period of one hour, twice daily for 5 days, and can be repeated after an interval of 2 days. (4) B.A.L. 4 mg/kg. of body weight every 4 hours is useful. BAL chelates lead both intracellularly and extracellularly. Two molecules of BAL combine with one atom of lead to form a complex that is excreted in the bile and urine. In the presence of renal impairment, BAL is the chelator of choice, as its main route of excretion is the bile. BAL should be given at least 4 hours before EDTA, as EDTA mobilises lead from tissue stores and aggravates symptoms of lead poisoning. (5) Pencillamine 0.3 to 0.5 g. orally one to 5 times daily is effective in excretion of circulating lead but is not as effective as EDTA. This may be continued for one to two months. (6) DMSA (succimer) is superior to EDTA. It is given in a dose of 10 mg/kg orally every 8 hours for 5 days, followed by the same dose every 12 hours for 14 days. (7) DMPS. (8) A diet poor in calcium, and ammonium chloride one g. ten times daily is given. By this lead deposited in the bones is mobilised into the blood and excreted. High doses of parathormone have similar effects. (9) Thiamine 10 to 15 mg/kg. (10) Treat the symptoms on general lines.

Post-mortem Appearances: They are not constant. A blue line may be seen on the gums. Paralysed muscles show fatty degeneration. The stomach and intestines may show ulcerative or haemorrhagic changes and are contracted and thickened. The liver and kidneys are contracted. The brain is very pale and greatly swollen. PAS-positive, pink-staining, homogeneous material may be seen in the perivascular spaces in the brain. The heart may be hypertrophied and there may be atheroma of the aorta and aortic valves. Bone marrow shows hyperplasia of leucoblasts and erythroblasts with a decrease in fat cells. Segmental demyelination of pripheral nerves may be seen. Eosinophilic intranuclear inclusions may be seen in hepatocytes and cells of the proximal tubules of the kidneys.

Cause of Death: In acute poisoning, death is due to gastroenteritis and subsequent shock. In chronic cases, malnutrition, intercurrent infection, failure of liver function, respiratory failure, renal failure and encephalopathy can all be the direct causes.

Absorption: Absorption of inorganic lead compounds from digestive tract is slow. Absorption is greater and more rapid by inhalation. Absorption from skin is poor. Tetraethyl lead, and other alkylated compounds are absorbed from the skin. Adults may consume up to 300 µg. of lead every day, but only about 10% of this is absorbed. Children absorb 50% of lead. Bullets or pellets lodged in joints, peritoneum, pericardium, or other soft tissues may result in lead poisoning. Accumulation and toxicity occurs if more than 0.5 mg/day is absorbed. Half life is 32 years in bone and 7 years in kidneys.

Distribution: Lead is normally present in almost all tissues. It is a typical cumulative poison. In poisoning, liver, kidney and spleen among the soft tissues, show the highest concentration. The bones contain large amounts, and also hair and nails. It is stored in the bones as phosphate and carbonate. The major proportion of lead in blood is found in the red cells. With continued exposure, lead gradually

becomes fixed to bone as inert and insoluble lead phosphate and carbonate. High calcium levels favours storage, while calcium deficiency causes lead to be released into blood stream. Lead is drawn to those areas of skeleton that are growing most rapidly, such as femur, tibia, and radius. Dense transverse bands or lead lines extending across the metephyses of the bones and iliac crest is significant. Lead lines seen on X-rays as densities are due to hypermineralisation. The width of the lead lines is related to the duration of the exposure. These lines reflect "bone growth arrest". They are seen only in heavy chronic poisoning (minimum 4 weeks). Multiple lead lines indicate repeated episodes of toxicity. They are most commonly seen between 2 to 5 years.

Excretion: Lead is excreted largely in faeces. Absorbed lead is excreted mostly in urine and also from epithelial tissues and sweat. A urinary excretion rate below 80 micrograms per day is normal.

TEST: Hydrochloric acid produces a white precipitate, soluble in boiling water, and crystallizing on cooling.

The Circumstances of Poisoning: Acute poisoning is very rare. Chronic poisoning is more common and is regarded as an industrial disease. Homicidal poisoning is rare. Accidental chronic poisoning occurs in workers with the metal. It is not used for suicide. Diachylon paste (lead oleate), or red lead is used locally for abortion. Red lead is sometimes used alone or mixed with arsenic as a cattle poison. Lead missiles remaining embedded in the tissues due to gunshot injuries may produce poisonous symptoms in 12 to 48 days.

COPPER

Copper as a metal is not poisonous. Copper compounds are powerful inhibitors of enzymes.

Poisonous Compounds: (1) Copper sulphate (blue vitriol) occurs in large, blue crystals. (2) Copper subacetate **(verdigris),** occurs in bluish-green masses or powder.

Signs and Symptoms: Symptoms appear in 15 to 30 minutes. There is a metallic taste, increased salivation, burning pain in the stomach with colicky abdominal pain, thirst, nausea, eructations and repeated vomiting. The vomited matter is blue or green. There is diarrhoea with much straining; motions are liquid and brown but not bloody. Oliguria, haematuria, albuminuria, acidosis and uraemia may occur. In severe cases haemolysis, haemoglobinuria, methaemoglobinaemia, jaundice, pancreatitis and cramps of legs or spasms and convulsions occur. The breathing is difficult, cold perspiration and severe headache occur. In some cases, paralysis of limbs is followed by drowsiness, insensibility, coma and death due to shock. Later deaths occur due to hepatic or renal failure or both.

Acute inhalation of a large dose of copper dusts or fumes can cause upper respiratory irritation resulting in sore throat and cough. Conjunctivitis, palpebral oedema and sinus irritation may also occur. Nasal mucous membrane may show atrophy with perforation. Exposure of the skin to copper compounds may cause an irritant contact dermatitis, and severe exposure may cause a greenish–blue discolouration of the skin.

Fatal Dose: Copper sulphate, 30 g.; copper subacetate, 15g.

Fatal Period: One to three days.

Treatment: (1) Stomach wash with one% solution of potassium ferrocyanide, which acts as an antidote by forming an insoluble cupric ferrocyanide. Emetics are contraindicated. (2) Demulcent drinks form insoluble albuminate of copper. (3) Haemodialysis is useful in the early stage of poisoning. (4) Castor oil is given to remove poison from intestines. (5) Chelation with pencillamine or EDTA or BAL.

Post-mortem Appearances: The skin may be yellow. Greenish-blue froth may be present at mouth and nostrils. The gastric mucosa and stomach contents are greenish or bluish. The gastric mucosa may be congested, swollen, inflamed, and occasionally eroded. The liver may be soft and fatty. Spontaneous haemolysis of blood and degenerative changes in proximal tubules of kidney may occur.

Chronic Poisoning: It may occur in workers with the metal due to inhalation of dust or from food being contaminated with verdigris. Chronic inhalation of copper sulphate spray can cause Vineyard sprayer's lung disease characterised by a histiocytic granulomatous lung. Chronic poisoning causes Wilson's disease.

The symptoms consist of gradual anaemia, green line on gums, nausea, vomiting, colic, diarrhoea, malaise and neuritis; peripheral neuritis, degeneration and atrophy of muscle may occur.

The presence of 'copper deposits in the tissues is called **chalcosis.** Copper may be deposited in the cornea resulting in a pigmented ring in the deeper layers. Chronic contact with swimming pool

water containing algicidal copper chemicals can cause green hair discolouration.

TEST: Ammonium hydroxide gives a greenish-blue precipitate, which is soluble in excess and forms a blue solution.

Absorption and Excretion: Copper is a normal constituent of the body. Copper content of the body is 150 mg. The safe daily intake of dietary copper is 2 to 3 mg. It is absorbed through the lungs, mucous membranes and raw surfaces. It is excreted more by the bowels than by the kidneys and in traces in saliva, bile and milk.

The Circumstances of Poisoning: (1) It is rarely used for homicide because of the colour and taste. (2) Suicide cases are rare. (3) Accidental poisoning results from eating food contaminated with verdigris which is formed from the action of vegetable acids on copper cooking vessels which are not properly tinned on the inside. Ingestion of food to which copper has been added to keep the green colour of the vegetables may cause poisoning. Children sometimes swallow copper sulphate attracted by its colour. (4) Sometimes, the salts are taken internally for abortion. (5) Rarely it is used as a cattle poison.

IRON

ACTION: Increased capillary permeability, postarteriolar dilatation, release of hydrogen ions, inhibition of mitochondrial function and corrosive action on gastric mucosa. Unbound iron circulates freely and is distributed within the cells and disrupts physiological mechanisms.

SYMPTOMS: They are divided into four stages. Few hours after ingestion, vomiting, abdominal pain and haemorrhagic gastroenteritis, shock, acidosis and coma occur. The second stage sets in 6 to 24 hours in which patient is symptom free. In the third stage (24 to 48 hours) metabolic acidosis, jaundice, hypoglycaemia, shock, coma with hepatic and renal failure occurs. After one to two weeks, in the fourth stage late compliations such as gastric stricture, and pyloric stenosis occur.

FATAL DOSE: 20 to 30 gm.

FATAL PERIOD: 24 to 30 hours.

TREATMENT: (1) Stomach wash with 5% sodium bicarbonate solution. Instil 5 to 10 gm. of desferrioxamine at the end of lavage. (2) Give plenty of egg and milk to form iron-protein complexes. (3) Magnesium hydroxide 1% solution orally. (4) Desferrioxamine 1g. i.m. followed by 500 mg 4th hourly for 2 doses and finally 500 mg 4 to 12 hourly upto a maximum of 6 g. in 24 hours. It can also be given in infusion 15 mg/kg/hr in normal saline. (5) Haemodialysis or exchange transfusion in severe cases.

P.M. APPEARANCES: In servere cases gastric mucosa shows haemorrhagic necrosis and perforation of the gastric or jejunal wall. The liver may show acute hepatic necrosis and the kidneys degenerative tubular changes.

THALLIUM

Thallium sulphate and thallium acetate are important salts, which are odourless, tasteless and water-soluble. They are used in the dye and glass industries and as rodenticides and insecticides.

SYMPTOMS: They occur after one to 12 days after a therapeutic dose due to overdose or idiosyncracy. In mild cases joint pains in legs and feet, loss of appetite, stomatitis, and drowsiness occur, which pass off in a few days. In severe cases, there is colic, vomiting, pain in muscles, joints and nerves, lethargy, motor and sensory neuropathies, convulsions, psychosis, optic neuritis, loss of hair, tremors, delirium and coma. There may be cardiac manifestations. Maculo-papular skin eruption having butterfly distribution on face is characteristic. There may be Mees lines on the nails. Death occurs due to respiratory failure due to paralysis of respiratory muscles. After recovery, the patient may suffer from peripheral neuritis resembling Guillain Barre polyneuritis. Death appears natural.

FATAL DOSE: one g.

FATAL PERIOD: 24 to 36 hours.

CHRONIC POISONING: Thallium triad is characterised by alopecia, skin rashes, painful peripheral neuropathy and mental confusion with lethargy.

TREATMENT: (1) Stomach wash with one percent potassium iodide or Prussian blue. (2) Activated charcoal. (3) Prussian blue (potassium ferric cyanoferrate) 250 mg/kg/day orally in two divided doses. (4) Haemodialysis along with haemoperfusion. (5) Forced diuresis.

P.M. APPEARANCES: Signs of asphyxia are present. Mucosa of stomach may be inflamed with submucous petechial haemorrhages. Alopecia, stomatitis, fatty heart and liver, renal damage, pulmonary and cerebral oedema are seen. It can be detected in the ashes of the burnt body.

MANGANESE

The important compounds of manganese are potassium permanganate and manganese dioxide. Parkinsonism symptoms are produced by inhalation of vapour of manganese for a long time.

POTASSIUM PERMANGANATE

It occurs as dark-purple, slender crystals, and has a sweet astringent taste. It is a powerful

oxidising agent and is used as a disinfectant.

Action: In strong solution or in the solid state, it acts as a corrosive or strong irritant, while after absorption it causes paralysis of the heart. It causes coagulation necrosis and brown discolouration of mucous membranes.

Signs and Symptoms: Burning pain from the mouth to the stomach, nausea, vomiting, intense thirst, difficulty in speaking or swallowing, dyspnoea, stridor, and a persistent spasmodic cough. The lips, gums, teeth, tongue, tonsils and pharynx are discoloured, inflamed, and superficially corroded. If seen soon after poisoning, the colour is purple-brown, but it becomes brown or dark-brown in few minutes, and later coal-black due to the formation of manganese dioxide. Shock is sometimes severe and there may be immediate collapse.

Fatal Dose: 5 to 10 g.

Fatal Period: Few hours.

Treatment: (1) Gastric lavage should be continued until the washings are colourless; 20% sodium thiosulphate should be used for the initial washings. (2) Demulcents. (3) Medicinal charcoal. (4) Symptomatic.

Post-mortem Appearances: Necrosis, haemorrhage and corrosion of the mucous membrane of lips, mouth, throat and stomach is seen. The liver and kidneys show degenerative changes.

Poisoning: Poisoning is usually suicidal. Accidental poisoning may occur in children who may eat the crystals in mistake for sweets. It is sometimes taken orally as an abortifacient. It is rarely used to produce fictitious injuries, e.g., to simulate the lesions of tertiary syphilis by applying a tablet to the skin for 10 to 20 minutes. Sometimes, a tablet is inserted into the vagina to procure abortion which causes ulceration of vaginal wall or cervix.

BARIUM

POISONOUS COMPOUNDS : (1) Barium Chloride: (colourless rhombic crystals). (2) Barium nitrate. (3) Barium carbonate: It is used as a rat poison. (4) Barium sulphate: It is a heavy, white, tasteless, odourless, powder. It is used for the X-ray examination of the gastrointestinal tract. It is insoluble. (5) Barium sulphide: (greyish-black powder). It is a deadly poison and used as a depilatory.

ACTION: It acts locally as an irritant of almost corrosive degree. After absorption it acts especially on muscle, including heart muscle.

SIGNS AND SYMPTOMS: The first effects are those of severe gastrointestinal irritation, namely nausea, vomiting and diarrhoea. It causes cramps and stiffness of the muscles, dilation of the pupil, paralysis of the tongue and larynx, and vertigo. The heart is affected early, the blood pressure rises, the pulse is slow and irregular and the heart may stop in systole. The most characteristic changes are an areflexia and paralysis.

FATAL DOSE: About one g.

FATAL PERIOD: Usually within 12 hours.

TREATMENT: (1) Wash-out the stomach and give sulphate of soda or magnesium sulphate in solution to precipitate the barium as insoluble sulphate. (2) 10 ml. of 10% sodium sulphate i.v. every 15 minutes to convert the soluble salt into insoluble sulphate. (3) Purging with magnesium sulphate and repeated bowel wash. (4) Symptomatic.

ANTIMONY

Metallic antimony is not poisonous. Antimony potassium tartrate (tartar emetic), occurs in the form of whitish or whitish-yellow powder, and antimony trichloride, (butter of antimony) are poisonous. The mode of action and symptoms of acute and chronic poisoning are similar to those produced by arsenic.

FATAL DOSE: Tartar emetic 0.2 to 0.5g; antimony trichloride 0.1 to 0.2 g.

FATAL PERIOD: Usually within 24 hours.

TREATMENT: (1) Stomach wash. (2) Tannic accid 4 g. by mouth forms an insoluble antimony tannate. (3) B.A.L. (4) Symptomatic.

Metal Fume Fever: It is caused by inhalation of fumes of zinc, copper, magnesium, nickle, mercury, lead, iron, silver, chromium, cadmium, cobalt, antimony, manganese and silver. The syndrome resembles a flue-like illness which starts 6 to 8 hours after exposure of fumes, with fever, chills, cough, dyspnoea, cyanosis, myalgia, salivation, sweating and tachycardia. Symptoms subside in 36 hours after stoppage of exposure.

Nickle: Exposure causes lung cancer, CADMIUM poisoning causes proteinuria and painful bone lesions.

CHAPTER 28

INORGANIC IRRITANT POISONS

PHOSPHORUS(P_4)

There are two varieties: (1) White or crystalline. It is used in fertilisers, insecticides, rodenticides, incendiary bombs, smoke screens, fireworks, etc. (2) Red or amorphous.

Action: It is protoplasmic poison, which affects cellular oxidation.

Signs and Symptoms:

(1) Fulminating Poisoning: This is seen when more than one gram is taken. These patients usually die within twelve hours due to shock and cardiovascular collapse because phosphorus has a direct action on the heart and blood vessels. Those who survive more than twelve hours are restless, delirious and some maniacal before death. Thirst, severe nausea, vomiting and retching occur.

(2) Acute Poisoning: (A) First Stage: Due to local irritation, symptoms occur within a few minutes to few hours after exposure and last from 8 hours to three days. Ingestion produces burning pain in the throat and abdomen, with intense thirst, nausea, vomiting, diarrhoea and severe abdominal pain. Breath and excreta have gralic-like odour. Luminescent vomit and faeces are diagnostic. Skin contact produces painful penetrating second and third degree burns which heal slowly.

(b) Second Stage: This is a symptom-free period lasting for two to three days.

(3) Third Stage: Symptoms of systemic toxicity occur from absorbed poison. There is nausea, vomiting, diarrhoea, haematemesis, liver tenderness and enlargement, jaundice, and pruritus. Haemorrhages occur into skin, mucous membrane and viscera, due to injury of blood vessels and inhibition of blood clotting. Renal damage results in oliguria, haematuria, casts, albuminuria and sometimes anuria. Involvement of central nervous system causes convulsions, delirium and coma. If the patient survives, symptoms may persist for a long time. Death may result from shock,hepatic failure, central nervous system damage, haematemesis or renal insufficiency.

Fatal Dose: 60 to 120 mg.

Fatal Period: 2 to 8 days.

Treatment: (1) Gastric lavage using 1:5000 solution of potassium permanganate oxidises phosphorus into phosphoric acid and phosphates, which are harmless. (2) Activated charcoal adsorbs the poison. (3) Stomach can be washed with 0.2% copper sulphate solution or 0.2 g. of copper sulphate may be given every 5 minutes until vomiting occurs. It coats the particles of phosphorus with a film of copper phosphide which is relatively harmless. As it has caustic properties and can cause acute copper poisoning adequate care should be taken. (4) Vitamin K, twenty mg. i.v. in repeated doses to combat hypoprothrombinaemia or blood transfusion. (5) The bowel should be evacuated with magnesium sulphate. (6) Wash out the bowel and repeat at intervals for several days. (7) Oil and fats shou d be avoided as they dissolve phosphorus and promote absorption. (8) Transfusion of glucose-saline and plasma with vitamins and noradrenaline is useful to protect the liver and to correct shock and dehydration. (9) If

Table (28–1) Difference between white and red phosphorus

	Trait	White phophorus	Red phosphorus
(1)	Colour:	White or yellow.	Reddish-brown.
(2)	Appearance:	Translucent, waxy cylinders.	Amorphous, solid mass.
(3)	Smell:	Garlicky.	Odourless.
(4)	Taste:	Garlicky.	Tasteless.
(5)	Luminosity:	Luminous in the dark.	Non-luminous.
(6)	Exposure to air:	Oxidises and emits white fumes; ignites at 34°C. and as such kept under water.	Non-oxidised, non-fuming, non-inflammable.
(7)	Use:	Fertilisers, vermin-killers, rodenticide, fireworks, gunpowder, etc.	On the sides of match box.
(8)	Toxicity:	Highly toxic.	Non-toxic.

Table (28–2) Difference in liver between phosphorus poisoning and acute yellow atrophy

	Trait	Phosphorus poisoning	Acute yellow atrophy
(1)	Size:	Enlarged at first, later may be normal or contracted.	Smaller, irregular, with a wrinkled capsule.
(2)	Colour:	Marbled.	Bright-yellow in earlier stage; deep-red later.
(3)	Consistency:	Soft, greasy and friable.	Very soft and flabby.
(4)	Structure:	Fatty degeneration of liver with some cellular necrosis; small haemorrhages on the surface and in the substance.	Disintegration and necrosis of most cells. Supporting connective tissue is not damaged.

renal failure is severe, peritoneal or haemodialysis may be required. (10) Burns should be thoroughly washed with one percent copper sulphate solution in water.

Post-mortem Appearances: There may be no obvious changes in fulminating poisoning. However, the oesophagus, stomach and intestines may show signs of irritation and luminous material may be found in the stomach. In acute poisoning, the body usually shows signs of jaundice. The gastric and intestinal contents may smell of garlic and be luminous. The mucous membranes of the stomach and intestine are yellowish or greyish-white in colour, and are softened, thickened, inflamed and corroded or destroyed in patches. Multiple smaller or larger haemorrhages are seen in the skin, subcutaneous tissues, muscles, and serosal and mucosal membranes of gastrointestinal and respiratory tract, under endocardium, pericardium, epicardium, peritoneum, in lungs, brain, leptomeninges and uterus. The liver becomes swollen, yellow, soft, fatty and is easily ruptured. Small haemorrhages may be seen on the surface and in the substance. In persons who survive for a week or longer, the appearances of acute yellow atrophy are present. The kidenys are large, greasy, yellow and show haemorrhages on the surface. The heart is flabby, pale and shows fatty degeneration. Fat emboli may be found in the pulmonary arterioles and capillaries. The blood may appear tarry and its coagulability is diminished. Phosphorus is oxidised in the body.

Chronic Poisoning: The frequent inhalation of fumes over a period of years causes necrosis of the lower jaw in the region of a decayed tooth. At first there is toothache, which is followed by swelling of the jaw, loosening of the teeth, necrosis of gums, and sequestration of bone in the mandible. This condition is known as **'phossy jaw'** (glass jaw) in which osteomyelitis and necrosis of the jaw occurs, with multiple sinuses discharging foul-smelling pus.

The systemic symptoms are nausea, vomiting, anorexia, pain in the stomach, indigestion, purging, pain in the joints, loss of weight, bronchitis, jaundice and anaemia.

The Circumstances of Poisoning: (1) Accidental poisoning in children may occur due to chewing of fireworks or by eating rat paste. (2) Phosphorus is occasionally used for homicide mixed with alcohol, coffee, etc. to diminish the taste and smell and administered for the following reasons. (a) There is delay in the appearance of symptoms. (b) Death occurs after few days. (c) Symptoms resemble acute liver disease. (d) The poison is oxidised in the body, if the patient survives long and as such cannot be detected. (3) Sometimes it is taken by mouth or introduced into the vagina to produce abortion. (4) Cases of poisoning may occur during war due to the phosphorus entering the body with fragments of hand grenades, bombs, bullets, etc. (5) For arson, white phosphorus covered with dung or wet cloth is thrown on huts. When the covering becomes dry, the roof catches fire.

IODINE: It occurs as bluish-black, soft and scaly crystals and has a metallic lustre and an unpleasant taste. It gives off a violet-coloured vapour at all temperatures, which has a characteristic odour.

ACTION: It is a protoplasmic poison fixing protein and causing necrosis. Vapours irritate respiratory passages.

SIGNS AND SYMPTOMS: Inhalation produces glottic and pulmonry oedema. Swallowed in the solid form, it acts as an acid corrosive poison. There is burning pain extending from the mouth to the stomach, intense thirst, salivation, vomiting, purging, giddiness, cramps or convulsive movements of the limbs and fainting. The lips and the angles of the mouth are stained brown. The vomited matter and excreta are dark-yellow or blue in colour, contain blood and have the peculiar odour of iodine. The urine is scanty or suppressed, red-brown in colour, contains albumen; metabolic acidosis, nephritis and renal failure occur. Pulse is slow and weak, skin cold and clammy and

there may be skin rashes.

FATAL DOSE: 2 to 4 g. (30 to 60 ml. of tincture).

FATAL PERIOD: 24 hours.

TREATMENT: (1) Evacuate the stomach by emetics or wash it out with warm water containing soluble starch and albumen. (2) One to five percent solution of sodium thiosulphate will convert tincture of iodine to harmless iodide. (3) Sodium chloride will promote excretion of iodide, as chlorides compete with iodide at the level of the tubules, thereby reducing the effects of iodism. (4) Give alkalis, arrow root, and barley water and treat symptomatically. (5) Activated charcoal binds iodine. (6) Skin lesion can be treated with 20% alcohol.

POST-MORTEM APPEARANCES: The mucosa of the stomach and intestines is inflamed, excoriated and may be brown. The heart, liver and kidneys may show fatty degeneration. There may be oedema of the brain.

CHRONIC POISONING: (IODISM): The symptoms are pain over the frontal sinus, running of the nose, conjunctivitis, bronchial catarrh, salivation, nausea, vomiting, purging, emaciation, lymphadenopathy, parotid swelling (iodide mumps) wasting of breasts, testes, etc. and acne or erythematous patches on the skin, urticaria, acne, etc. (ioderma).

Iodine rarely causes poisoning, but cases may occur from overdose and idiosyncrasy. Iodine is converted to iodide ion in the body. The normal iodide content of the blood is 2 to 5mg./100ml.

CHLORINE: It is a greenish-yellow gas having an unpleasant irritating odour. Exposure is likely only in laboratories, bleaching-powder factories and other chemical works. It is an oxidising agent and causes destruction of organic tissue.

It is an active oxidising agent and causes extensive destruction of organic tissue.

SIGNS AND SYMPTOMS : When inhaled, it has an irritant and suffocative effect. The symptoms of acute poisoning are intense irritation of the eyes and throat and mucous membrane of respiratory passages, with violent coughing and extreme dyspnoea, nausea, vomiting and spasm of the glottis. Death is caused by cardiac failure following inflammatory oedema of the lungs and pulmonary congestion. Chronic inhalation in repeated small doses may give rise to a chronic condition resulting in anaemia, cachexia, dental caries and progressive wasting.

FATAL DOSE : Exposure to one part in 1000 may prove fatal in five minutes.

FATAL PERIOD : Within two days.

TREATMENT : The victim should be removed from the poisonous atmosphere. Treat the shock, circulatory collapse and pulmonary oedema.

POST-MORTEM APPEARANCES : These are mainly asphyxial. There is inflammation of the respiratory tract, pulmonary oedema, rupture of alveolar walls, haemorrhages and thrombosis in the lung beds and increased viscosity of the blood.

IRRITANT MECHANICAL POISONS

They are not absorbed into the body, but they act mechanically and have only local action, and cause irritation of the gastrointestinal canal when swallowed. Powdered glass, diamond powder, pins, needles, nails, chopped animal and vegetable hair are the examples.

POWDERED GLASS: Symptoms: There is sharp burning pain in the throat, stomach and intestines, nausea, vomiting, usually constipation but rarely diarrhoea. Death may result from shock, if stomach or the intestine is perforated. The fatal dose and fatal period are uncertain.

Treatment: Give bulky food and later emetics and purgatives.

Post-mortem Apperances: Erosions may be seen extending from the mouth to the upper part of small intestine. The mucosa of the stomach is covered with sticky mucus and the glass particles may be found in the stomach and intestines. The mucosa of the gastrointestinal tract is congested and may be inflamed.

Medico-legal Importance: It is rarely used for suicide or homicide. It is taken in powdered form mixed with some articles of food. Occasionally, it is used as a cattle poison.

CHAPTER 29

ORGANIC IRRITANT POISONS

Plant Toxins: Kingsbury has outlined a variety of compounds produced in or absorbed by plants which may cause toxic reactions when ingested by animals.

(1) Alcohols. (2) Alkaloids. (3) Polypeptides. (4) Amines. (5) Glycosides: (a) Cyanogenetic. (b) Goitrogenic. (c) Irritant oils. (d) Coumarins. (e) Steroids and triterpenoids. (i) Cardiac. (ii) Saponins. (6) Oxalates. (7) Resins or resinoids. (8) Phytotoxins. (9) Minerals: (a) Copper. (b) Lead. (c) Cadmium. (d) Fluorine. (10) Nitrogen: (a) Nitrites. (b) Nitrates. (c) Nitroses. (d) Gaseous oxides of nitrogen. (11) Compounds causing photosensitivity: (a) Primary photosensitisation. (b) Hepatogenic photosensitisation.

RICINUS COMMUNIS

The castor plant *(arandi)* grows all over India. Fruit is 1.2 to 2.5 cm. long, three-lobed, softly spiny, blue-green or rose-red when immature, brown and bristly when ripe and dry. Seeds are variable, smooth, flattened–oval, mottled, light and dark-brown, or white with yellow-brown or gray markings, or wholly black or red. They are of two sizes, big and small. The small seeds are about 1.2 cm. long and 0.8 cm. broad, and resemble croton seeds. Entire plant is poisonous, though seeds are most poisonous, containing toxalbumen ricin, a water-soluble glycoprotein (highest level in the seeds), and a powerful allergen (CBA). The seeds are rich in a purgative oil., which is pale-yellow with a faint odour and acrid taste.

A toxalbumen or phytotoxin is a toxic protein, which resembles a bacterial toxin in action, and causes agglutination of red cells with some haemolysis and is antigenic. The'press cake' contains ricin and is poisonous, whereas castor oil contains ricinoleic acid, and is not poisonous as it does not contain ricin. **Phytotoxin** is a toxin produced by a plant. Ricin, crotin and abrin are phytotoxins. Animal toxalbumens are snake and scorpion venoms.

Ricin is excreted by intestinal epithelium. The unbroken seeds are non-poisonous when swallowed and also when cooked.

Action: Ricin blocks protein synthesis through the inhibition of RNA polymerase. Ricin has a special binding protein that allows it to gain access to the endoplasmic reticulum in gastrointestinal mucosal cells causing severe diarrhoea.

Signs and Symptoms: Dust of the seeds may cause watering of the eyes, conjuctivitis, sneezing, acute nasal inflammation, headache, pharyngitis, asthmatic bronchitis, dermatitis and gastric upset.

Symptoms include burning in mouth, throat and stomach. Burning of the oral mucosa appears similar to an alkali burn. Salivation, nausea, vomiting, bloody diarrhoea, severe abdominal pain, thirst, impaired sight, weak rapid pulse, cramps in calves and abdominal muscles, haemolysis, drowsiness, delirium, convulsions, shallow breathing, uraemia, jaundice, dehydration, collapse and death. Ricin is excreted by the intestinal epithelium.

Fatal Dose: 5 to 10 seeds; ricin six mg.

Fatal Period: Two to several days.

Treatment: Gastric lavage; activated charcoal, demulcents; symptomatic.

POST-MORTEM APPEARANCES: The mucosa of the gastrointestinal canal is congested, softened and inflamed with occasional erosions and submucous haemorrhages. Ricin produces haemorrhagic inflammation of the gastrointestinal tract even when given subcutaneously. Dilation of the heart, haemorrhages in the pleura, oedema of the liver, kidneys, spleen and lungs are seen. Fragments of seeds may be found in the stomach or intestines. There may be haemorrhages in the internal organs.

The Circumstances of Poisoning: Accidental poisoning may occur in children from eating the seeds. Rarely the powdered seeds are given for homicide. The powder of seeds causes conjunctivitis when applied to the eye.

CROTON TIGLIUM

The seeds of croton *(jamalgota or naepala)* contain crotin, a toxalbumen which is not expressed with the oil. The oil is brown, viscid, has unpleasant odour and acrid, burning taste. Seeds are oval, dark-brown with longitudinal lines. They have no smell. Crotonoside, a glycoside, which is less poisonous is also present. The oil contains a powerful vesicating resin composed of crotonoleic acid, methyl crotonic acid and several other fatty acids.

Signs and Symptoms: There is hot burning pain from mouth to stomach, salivation, vomiting, purging, vertigo, prostration, collapse and death. Applied to the skin, the oil produces burning, redness and vesication.

Fatal Dose: 4 to 5 seeds; one to two ml. oil.

Fatal Period: Six hours to three days.

Treatment: Stomach wash, demulcent drink, and symptomatic.

Post-mortem Appearances: There is congestion, inflammation and erosion of the mucosa of stomach and intestines, and congestion of internal organs.

Circumstances of Poisoning: (1) Accidental poisoning results from swallowing croton oil by mistake, or when taken in large doses as a purgative, or by eating seeds or inhaling their dust. (2) Suicide and homicide are rare. (3) The root and oil are sometimes taken internally as an abortifacient. (4) Oil is used as arrow poison.

ABRUS PRECATORIUS

It is also known as jequirity, indian liquorice, *rosary bead, gunja or rati.* It is a slender, twining, climbing plant, woody at base and is found all over India. Leaves are compound feather-like with ten to fifteen pairs of narrow leaflets, one to two-and-half cm. long. Flowers are pea-like, one cm. long, purple, pink, yellowish or whitish . Seed pot is two-and-half to five cm. long, borne in clusters, green when immature, becoming brown and dry, splitting open and remaining on vine with four to six seeds exposed. The seeds are egg-shaped, bright scarlet colour with a large black spot at one end, 8 mm. long and 6 mm. broad, and weigh 105 mg. on an average. Seeds may be white with black spot, all black, yellow or blue. The seeds contain an active principle abrin, a toxalbumen, which is similar to viperine snake venom; also present are abrine (N-methyltryptophan), an aminoacid, haemoglutinin in the cotyledons; a lipolytic enzyme, and abralin, a glucoside. All parts of the plant are poisonous. Seeds are tasteless and odourless.

Abrin inhibits protein synthesis and causes cell death.

Signs and Symptoms: Symptoms may be delayed from a few hours to two or three days when taken by mouth. They include severe irritation of upper G.I. tract, abdominal pain, nausea, vomiting, bloody diarrhoea, weakness, cold perspiration, trembling of the hands, weak rapid pulse, miosis and rectal bleeding. Delayed cytotoxic effects occur in the CNS, liver, kidneys and adrenal glands 2 to 5 days after exposure.

When an extract of seeds is injected under the skin of the animal, inflammation, oedema, oozing of haemorrhagic fluid from the site of puncture, and sometimes necrosis occurs surrounding the site of injection. The animal does not take food and drops down after three to four days and cannot move. Tetanic convulsions occur or the animal becomes cold, drowsy or comatose and dies. The symptoms resemble those of viperine snake bite, and as such poisoning is not suspected by the owner.

In man, at the site of injection, painful swelling and ecchymosis develops, with inflammation and necrosis. Ingestion of seeds or extract can cause haemorrhagic gastritis. There is faintness, vertigo, vomiting, dyspnoea, and general prostration. Convulsions may precede death from cardiac failure.

Fatal Dose: 90 to 120 mg. (one to 2 seeds) by injection. Subcutaneously abrin is 100 times as toxic as by the oral route.

Fatal Period: Three to five days.

Treatment: (1) Gastric lavage. (2) Activated charcoal. (3) Purgative. (4) Injection of antiabrin. The needle should be dissected out.

Post-mortem Appearances: Fragments of the needle may be found. There is oedema at the site of injection, and petechial haemorrhages under the skin, pleura, pericardium and peritoneum. The internal organs are congested and show haemorrhages.

The Circumstances of Poisoning: (1) The seeds are used for killing cattle and rarely for homicide. The cattle are poisoned by leather workers to obtain hides cheaply or for revenge. The seeds are decorticated, and alone or mixed with datura, opium and onion, are made into paste with spirit and water, and small sharp-pointed spikes or needles or *'suis'* are prepared, which are then dried in the sun. The needles are 15 mm. long and weigh 90 to 120 mg. Two needles are inserted by their base into holes in a wooden handle. A blow is struck to the animal with great force which drives the needle into the flesh. (2) For homicide, the needle is kept between two fingers, and the person is slapped which drives the needle into the body. (3) Powdered seeds are used by malingerers to produce conjuctivitis. (4) When taken internally they disturb the uterine function and prevent conception. (5) The seeds are used as an abortifacient and as arrow poison.

ERGOT

Ergot is the dried sclerotinum of the fungus Claviceps purpurea, which grows on cereals like rye, barley, wheat, oats, etc. It gradually replaces the

grain forming a curved, dark-purple or black compact mass, 0.9 to one cm. long, half-cm. thick, with lengthwise ridges, and has peculiar odour and disagreeable taste. It contains about thirty alkaloids, but ergotoxine, erogotamine and erogometrine (ecbolics) are important.

Ergot alkaloids exert their primary effect by stimulating adrenergic receptors, both peripherally and centrally. They directly stimulate muscle fibres.

Signs and Symptoms: In acute cases, there is nausea, vomiting, diarrhoea, giddiness, tightness in the chest, difficulty in breathing, marked muscular weakness and exhaustion. There may be tingling and numbness in the hands and feet, paraesthesias, followed by twitchings or cramps in the muscles. Bleeding from the nose and other mucous surfaces is common after large doses. The pulse is rapid and weak, pupils are dilated with dimness of vision, blood pressure is raised.

Chronic Poisoning (ergotism): There is tingling and numbness of the skin; vasomotor disturbances leading to dry gangrene of the fingers, toes, ears, nose, etc. There is a sensation of insects creeping under the skin. Neurologic disorder characterised by hallucinations, ataxia, and convulsions may occur.

Fatal Dose: 2 to 10 g.

Fatal Period: One to several days.

Treatment: (1) Wash the stomach. (2) Activated charcoal. (3) Syrup of ipecac. (4) Cathartics. (5) Nitroprusside for hypertension and severe ischaemic changes. (6) Diazepam 0.1 mg./kg. i.v. slowly for convulsions. (7) Vasodilators, e.g. nitrites are useful.

Post-mortem Appearances: They are not characteristic. The internal organs are congested. There is degeneration of intima of smaller arterioles and thrombus formation.

Poisoning: The consumption of bread made with contaminated rye is the chief cause of ergotism. Ergot is commonly used as an abortifacient.

CAPSICUM ANNUM

Capsicum or chillies *(red pepper; mirch)* have a pungent odour and taste, and are used as a condiment. They are not fatal. The active principles are capsaicin (alkaloid) and capsicin.

Signs and Symptoms: In large doses, it acts as an irritant poison and causes difficulty in swallowing, pain in the stomach and inflammation of oesophagus and stomach. Applied to the skin or mucosa it causes irritation. Powder thrown in the eyes causes severe irritation leading to lachrimation, burning pain and redness.

Treatment: (1) Bathe affected skin in vinegar or ice-cold water. (2) If ingested, sucking of ice cubes, or sips of ice-cold water.

Criminal Uses: (1) Powder is thrown into the eyes to facilitate robbery. (2) When theft or confession of some guilt has to be obtained, the person is tortured by introducing the powder into vagina, rectum or urethra or by rubbing on the female breasts.

SEMECARPUS ANACARDIUM

Marking nuts *(bhilawa)* are balck, heart-shaped with rough projection at the base. They have a thick, cellular pericarp, which contains an irritant juice which is brownish, oily and acrid but turns black on exposure to air. The active principles are semecarpol and bhilawanol.

Signs and Symptoms: Applied externally, the juice causes irritation and a painful blister which contains acrid serum, which produces eczematous eruptions of the neighbouring skin with which it comes into contact, and there is itching. The lesion resembles a bruise. Later an ulcer is produced, and there may be sloughing.

Taken by mouth, the juice causes less irritant action. In large dose, it produces blisters on throat and severe gastrointestinal irritation, dyspnoea, tachycardia, hypotension, cyanosis, absence of reflexes, delirium, coma and death.

Fatal Dose: Five to ten g.

Fatal Period: 12 to 24 hours.

Post-mortem Appearances: Blisters are seen in the mouth, throat and stomach which are congested and inflamed.

Circumstances of Poisoning: (1) Accidental poisoning may result from the administration of juice internally by quacks. (2) Homicidal and suicidal poisoning is rare. (3) Sometimes, the juice is introduced into the vagina as a punishment for infidelity. (4) To support a false charge of assault the juice is applied to skin which produces lesions simulating bruises. (5) The juice may be thrown on the body to cause injury. (6) For criminal abortion, the bruised nut is applied to the cervical os. (7) Malingerers use the juice to produce ophthalmia.

CALOTROPIS

Calotropis gigantea *(akdo, madar)* has purple flowers and calotropis procera has white flowers. They grow wild throughout India. The active principles are uscharin, calotoxin, calactin and

calotropin (glycoside). The milky juice in addition contains trypsin. The leaves and stem when incised yield thick acrid, milky juice.

Signs and Symptoms: Applied to the skin, it causes redness and vesication. When taken by mouth, the juice produces an acrid bitter taste, and burning pain in throat and stomach, salivation, stomatitis, vomiting, diarrhoea, dilated pupils, tetanic convulsions, collapse and death.

Fatal Dose: Uncertain.

Fatal Period: 6 to 12 hours.

Treatment: Stomach wash, demulcents and symptomatic.

Post-mortem Appearances: Dilated pupils, froth at the nostrils, stomatitis, and inflammation of gastrointestinal tract are seen. The abdominal viscera and brain are congested.

Circumstances of Poisoning: (1) The flowers, leaves, root and juice are used in Indian medicine. (2) The juice is taken by mouth or introduced into uterus on an abortion stick for criminal abortion. (3) It is sometimes used for infanticide and rarely for suicide or homicide. (4) Juice is used as a vesicant, depilatory and for chronic skin infection. (5) Occasionally, to produce artificial bruise. (6) As a cattle poison, it is smeared on a cloth and pushed into the rectum of the animal or is given with fodder. (7) It is sometimes used as arrow poison. (8) The root of calotropis procera is highly poisonous to cobras, and other poisonous snakes, which cannot stand even its smell.

PLUMBAGO ROSEA *(lal chitra)*

PLUMBAGO ZEYLANICA *(chitra)*

The root contains as an active principle, plumbagin, a crystalline glycoside.

Fatal Dose: Uncertain.

Fatal Period: Few days.

Treatment: Stomach wash, demulcents and symptomatic.

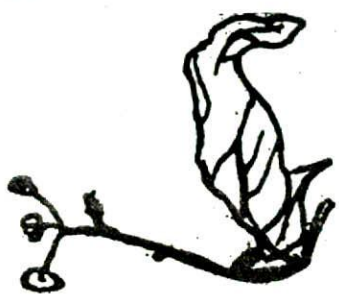


Fig. (29–1). Plumbago zeylanica.

Symptoms: Applied externally, roots produce irritation and blisters. Taken internally, there is burning pain from mouth to stomach, vomiting, thirst, diarrhoea, collapse and death.

Post-mortem Appearances: Signs of gastroenteritis and congestion of internal organs are found.

Circumstances of Poisoning: (1) Roots are taken by mouth or applied as paste to the cervix or to abortion stick for criminal abortion. (2) Roots are rarely used for homicide. (3) Sometimes, the paste made from the roots is applied to the skin to simulate a bruise.

CANTHARIDES

The Spanish fly (blister beetle) is two cm. long, and 0.6 cm. broad. The powder of the dried body is greyish-brown and contains shiny green particles. The active principle is cantharidin. It is used externally as an irritant. The Indian fly (beetle) is 2.5 cm. long and 0.8 cm. broad. It contains about 2.9% cantharidin. Cantharidin is readily absorbed from all surfaces including the skin.

Symptoms: Applied to the skin, redness and burning pain are produced after two to three hours followed by vesication. Taken internally, symptoms appear in half to two hours. There is burning sensation in the mouth and throat, followed by pain in the stomach, nausea and vomiting of bloody mucus, severe thirst, difficulty in swallowing and speech. Later a dull pain is felt in the loins, the urine is scanty and bloodstained, though there is an increased desire to pass urine. Priapism may occur; there is often tenesmus. Abortion occurs in pregnant women. In severe cases, the patient becomes prostrated, convulsions occur, and death may take place in a condition of coma.

Fatal Dose: 15 to 50 mg. of cantharidin, or one-and-half to three g. of powdered cantharides.

Fatal Period: 24 to 36 hours.

Treatment: Stomach wash, demulcents and symptomatic.

Post-mortem Appearances: The mouth shows inflammation and sometimes vesication. The mucous membrane of the oesophagus is often swollen and engorged, and may show patches of ulceration. The mucosa of the stomach is markedly congested and shows petechial haemorrhages with foci of superficial erosion. These changes may extend to the upper portion of the small intestine. Particles of the insects

may be found sticking to the mucosa. The kidneys are acutely inflamed and there is haemorrhage in the renal pelvis and bladder. The bladder mucosa is inflamed and ecchymoses may be present. The surface of the heart and endocardium show haemorrhages. The lungs may be oedematous, and the air-passages contain blood-stained mucus.

Circumstances of Poisoning: (1) Accidental poisoning may occur by its external application as counterirritant. (2) It is rarely used for homicidal purposes. (3) It is used as an aphrodisiac, but the action is doubtful. (4) It is taken for criminal abortion.

SNAKES

There are more than 3500 species of snakes, but only about 250 are venomous. In India about 216 species are found, of which 52 are poisonous 15,000 to 20,000 people die every year out of about two lakhs snake bite cases. The poisonous snakes may be divided into five families. Only five of them are dangerously poisonous to man, i.e. king cobra, common cobra, common krait, Russell's viper and saw-scaled viper. The most common poisonous snake is common krait. (1) **(A) Viperidae:** Russell's viper, gaboon viper, saw scaled viper, puff adder. They are found in all parts of the world except the Americas. **(B) Crotalidae**: Rattlesnakes, pigmy rattlesnakes, copperheads, cottonmouths (water moccasins), pit viper, and the massasaugas, bushmaster. They are found in Asia and the Americas. The water moccasin is found in swampy areas or along the banks of streams. It is a strong swimmer and can bite under water. (2) **Elapidae:** Cobras, kraits, mambas, tiger snake, taipan, death adder, copperhead snakes, coral snakes. They are found in all parts of the world except Europe. (3) **Hydrophidae or sea snakes :** All sea snakes are poisonous but they seldom bite. (4) **Colubridae:** Boomslangs, bird snake of the African continent. (5) **Atractaspididae:**African and Middle Eastern burrowing asps or stilleto snakes also known as burrowing or mole vipers or adders, or false vipers. The king cobra lives in the dense rain forest of the hills, and is unlikely to be met with.

COMMON POISONOUS SNAKES: The cobra *(nag naja tripudians, naja naja, kala samp)* has a hood, which on dorsal side often bears a double or single spectacle mark, but it has sometimes an oval spot surrounded by an ellipse. The portion of the neck surrounding the spectacle mark is darker than the rest of the back, and is often speckled with small golden spots. The hood cannot be seen in a dead cobra, as the joints and neck become stiff. There are two black spots, and three black bands on the underside of the hood. The caudal scales are double. There is a white band in the region where the hood touches the body region. The colour is brown or dark. It grows to a length of about two metres. Maxillary bone extends beyond palate. Poison fangs are followed by one or two small teeth. The neck is dilatable. The king cobra

Table (29–1) Difference between poisonous and non-poisonous snakes.

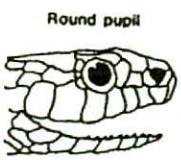
Trait	Poisonous snakes	Non-poisonous snakes
(1) Head scales:	(1) Small (vipers).	
	(2) Large, and (a) if there is an opening or pit between the eye and nostril (pit viper).	Large with the exceptions as mentioned, under the poisonous snakes.
	(b) Third labial touches the eye and nasal shields (cobra or coral snake).	
	(c) No pit and third labial does not touch the nose and eye and central row of scales on back enlarged; undersurface of the mouth has only four infralabials, the fourth being the largest (kraits).	
(2) Belly scales:	Large and cover entire breadth.	Small, like those on the back or moderately large, but do not cover the entire breadth.
(3) Fangs:	Hollow like hypodermic needles.	Short and solid.
(4) Teeth:	Two long fangs.	Several small teeth.
(5) Tail:	Compressed.	Not much compressed.
(6) Habits:	Usually nocturnal.	Not so.

Table (29–2) Difference between cobra and viper

Trait	Cobra	Viper
(1) Body:	Long and cylindrical.	Short, narrow neck.
(2) Head:	Small; seldom broader than body; covered by large scales or shields of special forms.	Large; broader than body; triangular and covered by numerous small scales.
(3) Pupil:	Round.	Vertical.
(4) Maxillary bone:	Carries poison fangs and other teeth.	Carries only poison fangs.
(5) Fangs:	Grooved, short, fine.	Canalised, long.
(6) Venom:	Neurotoxic.	Haemotoxic.
(7) Tail:	Round.	Tapering.
(8) Eggs:	Lay eggs.	Give birth to young ones.

(rajnag, nagraj, naja bungarus, humadryad), has a hood but no mark on it, and the length is about three to four metres. The colour may be yellow, green, brown or black and has yellowish or white cross-bands in the body. It is confined to the Western Ghats and it rarely bites humans. THE COMMON KRAIT *(karayat, bungarus caerulus, manyar, kalotaro, kawriya)* is steel-blue, often shining and has single or double white bands across the back, and a creamy-white belly. Its length is one to one-and-half metres. The stripes are not very distinct in the anterior region. The head is covered with large shields. Four shields are found on either side of the lower lip. The scales in the central row down the back are large and hexagonal. The tail is round. The plates under the tail like those on the belly are entire and not divided. These snakes are nocturnal in habit. THE BANDED KRAIT *(ahiraj, raj sanp, bungarus fasciatus, koelea krait)* is one-and-half to two metres in length. The tail ends bluntly and is swollen at the tip. It has a jet black five cm. wide cross-band alternating with a deep yellow band of the same size on its back. There is a black mark on the neck which is spread up to the eyes. It is usually found in North-Eastern States. RUSSELL'S VIPER OR DABOIA *(kander, charn viper, khadchitro)* has a flat, heavy and triangular head with a white V-shaped mark, the angle of the V pointing forwards. It has three rows of diamond-shaped black or brown spots along the back, the outer two rows consisting of spots ringed with white edges. Its body is whitish with dark semilunar spots. It narrows towards its tail, which is short. It can be identified by the entire broad plates on the belly, the small scales on the head, and the shield beneath the tail divided into two rows. It is

Fig. (29–2). Cobra binocellate (Najanaja).



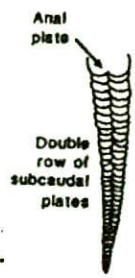


Fig. (29–3). Nonvenomous snake.

Fig. (29–4). Banded krait/(Bangarus fasciatus).

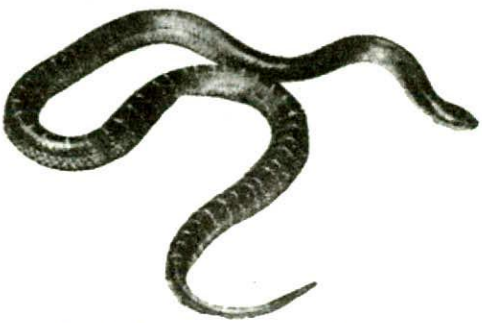


Fig. (29–5). Common krait (bangarus caeruleus).

heard to hiss loudly and continuously. The saw-scaled viper *(afai, echis carinate)* is brown, half metre in length, and has wavy white line on each flank of the back with diamond-shaped areas between these two lines. It has a triangular head, the upper surface of which is covered with a white mark resembling a bird's foot- print or an arrow. The tail is short and tapering. The broad belly plates with brown or dark spots, small scales on the head, and entire shields beneath the tail are the distinguishing features. PIT VIPERS have a pit located between the nostrils and the eyes.

Banded krait and common green pit viper (*bamboo snake*) are also poisonous. Rat snake is not poisonous.

Common krait, cobra, Russell's viper, and saw-scaled viper are seen all over India. Banded krait is seen mainly in East India, and King cobra in Western Ghats.

Sea Snakes: Twenty types are seen in Indian waters, all of them being poisonous. They have small eyes, prominent nostrils on the top of the head, broad ventrals, small tuberculated dorsal scales and paddle-shaped flat tails. They are black, greenish-black or bluish-black with or without bands.They can be found is estuaries, rivers and even fresh water lakes.

Poison Glands: They are the salivary glands of the snake and are situated behind the eyes, one on each side of the head above the upper jaw.

Fangs: All the poisonous snakes have two fangs. These are curved teeth situated on the maxillary bones and lie along the jaws, and are covered by a flap of mucous membrane. When the snake is about to bite, they become erect and point directly forward. They are bigger than the other teeth and are grooved or canalised in poisonous snakes, and are solid in non-poisonous snakes. When a poisonous snake bites, it normally leaves two deep faint impressions, the distance between them being 8 mm to 4 cm. A side swipe may produce a single puncture and also small marks of other teeth. Non-poisonous snake bites leave a number of small impressions in a row.

The discharge orifice of a viper fang is usually well above its tip. The fang can penetrate deeply, but part or most of the venom may be ejected superficially or externally without entering the wound. As such, even a thin layer of clothing may afford great protection. As the venom is injected superficially by vipers, and also by elapids and hydrophids, about 20% of patients bitten by poisonous snakes do not show evidence of poisoning, even though the fangs have penetrated the skin, "dry bites". In sea snakes bites, symptoms are not produced in about 80% of bites. The exact number of fang marks vary because of glancing blows, multiple fangs, multiple strikes, or from protection of clothing or shoes.

Snake Venom: Venom is the saliva of the snake. Cobra venom is faint transparent yellow and is slightly viscous. When exposed to sun, it becomes slightly turbid. Russell's viper venom is white or yellow. The enzymatic components of snake venom cause local and systemic effects, and the non-enzymatic components provide lethality. (1) Enzymes include phospholipidase A, proteases, hyaluronidase, cholinesterase, hydrolases, transaminase, phospholipase, ATPase, ribonuclease, deoxyribonuclease, etc. They cause increase in cell wall permeability, with haemolysis, disruption and alteration of connective tissue, muscle and subcataneous tissue damage leading to necrosis, and promotion of i.v. clotting and fibrinolysis resulting in a defibrinated syndrome. (2) Peptides and polypeptides (lethal compounds) cause systemic effects. **(a) Haemorrhagins** are mainly toxic to the lung. They disrupt endothelial cell functions and alveolar septa and cause pulmonary congestion and increased lung weight. These effects also occur locally at the site of bite, causing haemorrhagic oedema and systemic bleeding leading to shock. **(b) Cardiotoxin** found particularly in cobra venom is toxic to the heart. It also affects skeletal and smooth muscle membranes and neuromuscular junction. **(c) Neurotoxins** can be found in elapid, hydrophid, vipirid and crotalid venoms. They are neuromuscular non-depolarising blocking agents, which produce a curare-like effect and paralysis. Cholinesterase is rich in venom of cobra and krait. Snake venom also contains acetylcholine and 5-hydroxytryptamine.

The concentration of venom shows diurnal and seasonal variation. Bites inflicted at nights and immediately after hibernation are the most severe. Venom travels in the body through lymphatics and superficial veins.

Crotalidae venoms are rich in proteolytic enzyme activity. The viperidae venoms have lesser amounts and the elapidae and hydrophidae venoms have little or no proteolytic activity. Hyaluronidase is found in every snake venom. L-aminoacid oxidase is found mainly in the viperoid and crotalid venoms. It is not found in sea snake venoms. Cholinesterase is rich in elapid venoms, while it is absent or found only

in small amounts in viperid and cortalid venoms. **Proteolytic enzymes** cause digestion of tissue proteins and peptides and produce marked tissue changes and destruction. They may contribute to the hypersensitive action of snake venom. **Phosphatidases** cause haemolysis and most of the effects on the heart and circulation. Haemolysis by venom is accelerated by lecithin. Phospholipases, A, B, C, and D are catalysts involved in the hydrolysis of lipids. Cholinesterase catalyses the hydrolysis of acetylcholine to choline, and acetic acid. **Lecithinase** attacks the lipid layers of the endothelial cell linings, producing lysolecithin and helping in increase of fragility and permeability for breakage of cells. Proteolytic enzymes produce local changes in vascular permeability leading to oedema, blistering, bruising, and necrosis. Biological amines, such as histamine and 5-hydroxytryptamine may contribute to local pain and permeability changes at the site of bite.

The colubrine and elapidae venom is mainly neurotoxic, and has a primary toxicity for the respiratory and cardiac centres. It can produce marked cardiac or vascular changes, or have a direct effect on the blood. The viperine venom is mainly haemolytic and causes intravascular haemolysis and depression of the coagulation mechanism. It can produce changes in the nervous system or in vascular dynamics. Russell's viper venom contains two proteases which activate the blood clotting cascade. As a rule, one of the modes of action far exceeds the other. The sea snake venom is myotoxic.

Signs and Symptoms: Ophitoxaemia is poisoning by snake venom. Most of the snake bites are from non-venomous snakes. In venomous snake bites, inadequate snake venom is injected in more than half of the cases, producing mild symptoms. The most common symptom following snake bite (poisonous or non-poisonous) is fright, especially the fear of rapid and unpleasant death. Due to fright, the victim may become semiconscious with cold clammy skin, hypotension, feeble pulse and rapid breathing. These emotional symptoms appear within few minutes of the bite. Sometimes, it produces psychological shock and even death. It may also give rise to tetanus or gas gangrene. The signs and symptoms depend upon: (1) the nature, location, depth and number of bites; 98% of the snake bites occur over the extremities; (2) the length of time the snake holds on; (3) the extent of anger or fear that motivates the snake; (4) the amount of venom injected; (5) the species and size of the snake; (6) the condition of its fangs and venom glands; (7) the age and size of the victim; (8) the vicitim's sensitivity to the venom; (9) the pathogens in the snake; and (10) the first aid and medical care.

Cobra: Local symptoms start within 6 to 8 minutes. A small reddish wheal develops at the site of bite. The bitten area is tender with slight radiating burning pain and oozing of bloodstained fluid. Swelling may be minimal or even absent. Systemic symptoms appear after about 30 minutes. The patient feels sleepy, slightly intoxicated, weakness of legs, and is reluctant to stand or move. Nausea and vomiting are sometimes the early symptoms. Weakness of the muscles increases, and develops into paralysis of the lower limbs. The paralysis then spreads to the trunk, and affects the head which falls forward. The eyelids also hang down. After half to one hour, there is excessive salivation and even vomiting, headache, vertigo, paraesthesia around the mouth and myalgia. This is followed by paralysis of the facial muscles, palate, jaws, tongue, vocal cords, neck muscles and muscles of deglutition become progressively flaccidly paralysed to which there is difficulty in speech and swallowing. There may be extraocular muscle weakness, ptosis, and strabismus. After about two hours, the paralysis is complete. Respiratory arrest may occur due to obstruction of upper airway by the paralysed tongue or inhaled vomitus, or due to paralysis of intercostal muscles and diaphragm. Though the patient is conscious, he is not able to speak. Coma sets in and finally the respirations stop with or without convulsions and the heart stops. In cases of recovery, the skin and cellular tissues surrounding the bite mark undergo necrosis.

Krait: Symptoms resemble those of cobra bite, but there is no swelling or burning pain at the site of the bite, and the convulsions are milder, while the feeling of drowsiness and intoxication is more intense. Albumin appears in urine.

Russell's Viper and Echis Carinate: More than 50% of the victims have minimal or no poisoning, as little or no venom is injected. About 25% will develop serious generalised poisoning, but death is rare. When venom is injected, the spot develops a severe pain within eight minutes. The area around the bite is red and painful. The onset of swelling starts within fifteen minutes and there is often blood-stained discharge from the wound.

Persistent bleeding from bitesite is a constant feature. Blisters begin to appear in about 12 hours in and around the bitesite, progressing subsequently to involve the entire limb. When the amount of venom injected is less, pain and swelling restricted to below the elbow or knee, and some nausea disappear within one to two days. In moderate poisoning, there is a marked feeling of intense pain, vomiting, giddiness, sweating, abdominal pain, dilatation of the pupils, getting insensitive to light and in about one to two hours, there is marked collapse and often complete loss of consciousness. Skin temperature is raised. Tingling and numbness over the tongue and mouth or scalp and paraesthesia around the wound occur. These symptoms usually subside within the next few hours. There is local extravasation of blood, and swelling spreads as far as the trunk in one to two days, without further generalised symptoms. Though the limb is swollen and red, it is usually not tender. Haematuria may be seen within a few hours of the bite. The local swelling and discolouration, and sometimes a few blisters heal without necrosis within one to four weeks. In about 10 to 15% of the cases, extensive necrosis of skin, s.c. tissues and muscles may occur followed by epistaxis, haemoptysis, ecchymoses, intracranial and subconjunctival haemorrhages, and bleeding into the floor of the mouth, tympanic membrane, G.I and G-U tract, retroperitoneum and intraperitoneum. In severe cases, the main feature is the persisting shock. Blood may show haemoconcentration early, then a decrease in red cells and platelets, and urine contains blood, sugar and protein. Bleeding and clotting time are usually prolonged. A haemorrhagic syndrome with blood-stained sputum, haemorrhages from the gums, rectum, the site of bite, etc., occur due to the increased coagulation time. Intravascular haemolysis may lead to haemoglobinuria and renal failure. Petechial haemorrhages are common. In systemic poisoning, the blood becomes defibrinated and therefore will not clot. Increasing respiratory depression, blurring of vision, headache, dizziness and weakness often occur. Towards the end, there is an extensive suppuration and sloughing, followed by a malignant oedema of the bitten area. Paralysis does not occur. Death is usually due to shock and haemorrhage. In the case of echis, death may not occur, but the secondary symptoms continue for days, and the haemorrhages are severe and the wound shows mild necrosis. The patient should be observed for 12 to 24 hours.

Sea Snakes: Bites cause little or no local reaction. After half to one hour, the patient develops pain, stiffness and weakness of the skeletal muscles. Sea snake bites result in marked polymyositis with a limb-girdle distribution. Trismus occurs in early stage. Later, flaccid paralysis develops, beginning with ptosis. Muscle enzymes and plasma potassium levels are increased and myo-globinuria with renal failure may occur. Marked weakness of muscles persists for several months. Death may occur due to cardiac arrest or paralysis of respiratory muscles.

Fatal Dose: Cobra 12 mg; Russell's viper 15 mg; echis 8 mg; krait 6 mg; of dried venom. The approximate yield in one bite in terms of dry weight of lyophilised venom is: cobra 170 to 325 mg; Russell's viper 130 to 250 mg; krait 10 to 20 mg; and echis 20 to 35 mg.

Fatal Period: Cobra half to six hours; viper one to two days.

Diagnosis: (1) Snake specific venom antigens have been detected in wound swabs, aspirates or biopsies, serum, CSF, urine and other body fluids. As such, skin and underlying tissue surrounding the fang punctures, wound and blister aspirates, serum and urine should be collected. (2) Radioimmunoassay (RIA) is most sensetive and specific which can detect venom levels of 0.4 µg/l. (3) Enzyme immunoassay (EIA) is commonly used as it is simple and can detect venom levels of 5 µg/l. (4) Cholinesterase and thromboplastin may be detectable in bitten are of skin if there is no bacterial infection or putrefaction, by radioimmunoassay method. (5) Immunological detection of small amounts of venom antigens in body fluids can be done by ELISA. (6) A swab taken from the wound site or extract from the skin is injected into a frog for evidence of toxicity. Urinary venom may remain detectable even though the victim is treated with antivenom.

First Aid: (1) Assure the patient. (2) Apply firm pressure over the bitten area, which delays absorption of venom. (3) Immediately apply a broad firm bandage (Sutherland wrap) on the bitten area and around the limb. As much of the limb should be bandaged as is possible. It should be tight enough to occlude the superficial venous and lymphatic return, but not the arterial or deep venous flow. In bites on the trunk, head or neck, apply firm pressure over the bitten area. (4) Immobilise the limb, as

movement can accelerate the spread of venom. Avoid elevation of an extremity, as it may hasten systemic absorption of venom. (5) Local incision and suction should not be done as it can cause local bleeding and nerve injury. (6) Do not suck venom out of the wound, and do not use chemicals or medicines on the wound. (7) The wound should not be cauterised as it actually seals the poison within the tissues. (8) Cryotherapy is not of much use. (9) Clean the wound with soap and water, or iodine and cover with a sterile dressing. (10) Make patient lie on one side in the recovery position so that the airway is clear, in case of vomiting or fainting.

If a patient is brought after few hours (4 to 6) of snake bite with mild local swelling and no systemic symptoms, a watch should be kept on him.

Treatment: (1) Once the venom enters circulation, polyvalent antisnake venom serum should be given to neutralise it. The serum should be injected soon after the bite. 20 ml. is given i.v. 5 ml/min. or diluted in 500 ml. distilled water or normal saline and infused over 30 to 60 minutes. Children require the same dose. It is repeated after one hour or even earlier, if symptoms persist. Further doses should be repeated every 6 hours until the symptoms disappear completely. This serum is prepared by hyperimmunising horses against the venom of the four common poisonous snakes, i.e., cobra, common krait, Russell's viper and sawscaled viper. Plasma obtained from the hyperimmunised horses is concentrated and purified. The serum is lyophilised by drying it from the frozen state under high vacuum. It is prepared in the Haffkine Institute, Mumbai, King Institute, Chennai, Serum Institute, Pune, and at Kasauli in India, and is available in the form of lyophilised powder in an ampoule, which retains potency for about five years. It is useful when given within four hours of bite. It is of less value if delayed for eight hours, and is of dobutful value after twenty-four hours. (2) The serum will produce minor hypersensitivity recations, severe serum sickness and even acute anaphylaxis in sensitive persons. Serum sickness often develops in a few days to weeks after the use of horse serum. To test the sensitivity, 0.02 to 0.5 ml. of 1: 10 dilution of serum is injected intradermally. In positive reaction, a wheal one cm. in diameter surrounded by an erythema of about the same width develops in 5 to 20 minutes. For desensitisation 0.1 ml. of 1:1000 dilution is given s.c., and the dose is increased every 15 minutes as follows: 0.2 ml and 0.5 ml. Repeat the same regimen with 1:10 solution and finally with undiluted antivenom. The alternative method is I.V. administration of antihistamine followed by an infusion of adrenaline (one mg disolved in 100 ml. saline). **Dose:** (1) Minimal symptoms: Local swelling but no systemic reactions, 5 vials. (2) Moderate: Swelling progressing beyond site of bite with systemic reaction, 10 vials (3) Severe: Marked local reaction, severe symptoms, 10 to 15 vials. (3) If the antisnake venom is not available, 40 ml. of antivenene is given i.v. and repeated as required. It is effective for cobra and Russell's viper bites. (4) When treating viper bite a watch should be kept on prothrombin time. (5) If there are signs of neuroparalysis, give half mg. neostigmine hourly. Before every injection, half mg. atropine should be given to block muscarinic side effects. (6) Heparin 1000 to 5000 i.u. may be given i.v. if there are clotting abnormalities. (7) Inject tetanus antitoxin or a booster dose of tetanus toxoid. (8) A broadspectrum antibiotic should be given if there is severe tissue involvement. (9) In viper poisons, sedatives may be given to relieve pain and nervousness. (10) In case of collapse, general stimulants are of value. (11) Antihistamines i.v. and cortisone help in relieving the symptoms. (12) In severe poisoning, infusion of normal saline or transfusion of blood or plasma are very useful. (13) Haemodialysis may be necessary. Peritoneal dialysis is better. (14) Give paracetomol for pain, but aspirin should not be given, as it may make the patient bleed. (15) Surgical debridement of the blebs, bloody vesicles, and superficial necrosis may be necessary.

Post-mortem Appearances: Poisonous snakes leave two or occasionally one fang mark. Non-poisonous snakes leave a semicircular set of tooth-marks. The punctures are one-and-half cm. deep in colubrine and two-and-half cm. deep in viperine bites. Sometimes, the bite marks may not be visible. In colubrine bite, the site of bite contains fluid and haemolysed blood causing staining of vessels. In viperine bite, there is discolouration, swelling and cellulitis about the mark and haemorrhages occur from the puncture and mucous membranes. Haemorrhages into the bowel, purpuric spots on pericardium, and haemorrhages in the lungs and in many tissues may be seen. Kidneys are inflamed. Internal organs are congested. Washing

from the bite area may contain cholinesterase or thromboplastin. The skin and underlying tissue surrounding fang marks should be removed for analysis. ELISA (enzyme-linked immunosorbent assay) can identify the nature of venom from the bite site.

Absorption and Excretion: Snake venom is poisonous only when injected, and is harmless when taken by the mouth, as it is not absorbed from the stomach. It is excreted by kidneys, milk and probably by salivary glands and the mucous membranes.

The Circumstances of Poisoning: (1) Poisoning is as a rule accidental. (2) Occasionally, a murder is committed by throwing a poisonous snake on the bed of sleeping person. (3) It is very rarely used for suicide. (4) Cattle are sometimes poisoned by snake venom. For this, a cobra is shut up in an earthen vessel containing a banana and heat is applied to the vessel. The snake being irritated, bites the fruit and the venom is injected to the pulp, which is crushed and smeared on a rag. The rag is thrust into the animal's rectum by means of a split bamboo. (5) The bodies of animals killed by snake poisoning may be eaten without ill-effects, but their blood is poisonous and is fatal if injected into the human body.

Queen Cleopatra is reputed to have committed suicide by getting her self-bitten by a venomous snake.

SCORPIONS: There are more than 1250 species of scorpions. About 100 species are found in India. These are eight-legged arthropods and have a hollow sting in the last joint of their tail, which communicates by means of a duct with the poisonous glands, which secrete poison on stinging. The venom is a clear, colourless toxalbumen, and can be classified as either haemolytic or neurotoxic. Its toxicity is more than that of snakes, but only a small quantity is injected. The venom is a potent autonomic stimulator resulting in the release of massive amounts of catecholamines from the adrenals. It has also some direct effect on the myocardium. The mortality, except in children is negligible. Colour of scorpions varies from light yellow to black. Most scorpion stings occur on the extremities.

Signs and Symptoms: If the scorpion has haemolytic venom, the reaction is mainly local and simulates the viper snake bite, but the scorpion sting will have only one hole in the centre of the reddened area. The extremity will have oedema, pain and reddening. This usually lasts for one to two hours. The symptoms produced by a neurotoxic venom is similar to cobra bite. There is usually no marked reaction in the local area. Nausea, vomiting, extreme restlessness, fever, various types of paralysis, cardiac arrhythmias, convulsions, coma and cyanosis, respiratory depression, and death may occur within hours from pulmonary oedema or cardiac failure. The diagnosis is confirmed by ELISA testing.

Treatment: (1) Immobilise the limb, and apply a tourniquet above the location of sting. (2) Pack sting in ice, and incise and use suction, and wash the wound with a weak solution of ammonia, borax or potassium permanganate. (3) A local anaesthetic is injected at the site to lessen pain. (4) A specific antivenin is available for most species. (5) Calcium gluconate intravenously is of value to control local swelling. (6) Barbiturates should be given to reduce excitement and convulsions but morphine is contraindicated. (7) Atropine is valuable in preventing pulmonary oedema.

BEES AND WASPS: Honey bees have a barbed stinger which contain two lancets which become firmly attached to human skin. The stinger of the wasp does not have barbs. Fire ants have well developed abdominal stingers. They are commonly seen in mango trees. Bees leave their stings behind and can only sting once, but wasps and hornets do not leave their sting behind and can sting many times. Bee venom contains dopamine, histamine, neurotoxin, enzymes and toxic peptides. Wasp venom contains in addition serotonin. Ant venom mainly contains alkaloids and proteins. Painful and sometimes fatal reactions occur in humans. The reactions are usually local. Severe systemic reactions are not common. Venom contains histamine. The local reaction consists of pain, redness, and slight swelling at the site of the sting. Stings of the mouth, throat and sometimes of the face, neck or limbs cause oedema of the larynx or pharynx and obstruction.

Systemic toxic reactions occur due to multiple stings. There is gastrointestinal disturbance and shock. Vomiting and diarrhoea may be accompanied by faintness and unconsciousness. The attack lasts for 24 hours if not fatal.

The anaphylactic reaction may occur immediately or within twenty minutes. There is respiratory distress, faintness, and unconsciousness. A rash may develop. Death may occur in 2 to 15 minutes.

Treatment: (1) Apply a ligature above the site

of the sting and incise it. (2) The sting should be located and removed by tweezers. (3) Tincture of iodine or local application of antihistamine is useful. (4) Adrenaline is given to combat systemic reactions. (5) ACTH 25 mg. in a litre of normal saline is given by intravenous infusion. (6) Clacium intravenously is useful for urticaria.

CENTIPEDES: They have segmented bodies with a pair of legs on each segment and a pair of claws on the first segment, through which venom is injected. The length is from two to several centimetres. The colour may be greenish-black or black. They have poweful jaws and produce relatively large volumes of toxin, which may include histamine, serotonin, hyaluronidase, esterase and proteinases. They produce paired bites of pinpoint type with spacing of up to 12 mm. Fatal bites are rare.

Symptoms: Local swelling, excruciating pain, and necrosis, paralysis and contracture of extremities, cardiac irregularities, arthritis and meningism may occur. Symptoms subside in 2 to 3 days.

Lizards: The are no venomous lizards in India.

SPIDERS : Spiders are invariably poisonous but majority of species do not pose risk of death. Black widow or hour glass spider (neurotoxic) and violen spider or brown recluse (cytotoxic) produce severe toxicity, and act on the myoneural junction or peripheral nerve endings causing ascending motor paralysis or damage to peripheral nerve endings. Death may occur due to introduced infection (Staphylococus, Penicillium and several species of Bacillus) rather than venom. Spider fangs leave two closely spaced puncture marks on the skin. Nausea, vomiting, sweating, abdominal cramps, chest pain or tightness, difficulty in breathing, tachycardia, hypertension, restlessness, irritability, sweating and swollen eyelids occur. Some spiders may cause local tissue injury and ulcers at the bite site, which may spread over the bitten limb. Local swelling and local painful muscle spasms and tremors appear, which later involve muscles of the back, shoulder, thighs, legs, arms and face. There is circulatory collpase, convulsions and delirium. It may be confused with tetanus and strychnine poisoning.

Treatment: (1) Analgesics, antihistamines and antibiotics may be given if indicated. (2) Antivenin (3) Dapsone 50 to 100 mg. twice daily for 2 to 3 days may halt progression of lesions that are becoming necrotic.

Ants: They secrete formic acid by certain glands situated in the tail. Ant bite produces pain, irritation and swelling at the site of the bite.

CHAPTER 30
C N S DEPRESSANTS

CNS DEPRESSANTS

Classification: (1) Ethyl alcohol. (2) General anaesthetics. (3) Opioid analgesics. (4) Sedative hypnotics.

Sedative-Hypnotics: Sedative drugs are those that decrease activity, moderate excitement, and exert a calming effect. A hypnotic drug produces drowsiness and facilitates a state of sleep, resembling natural sleep.

Classification: (1) Barbiturates. (2) Benzodiazepines: diazepam, chlordiazepoxide, oxazepam, chlorazepate, flurazepam, lorazepam, temazepam, alprazolam, halazepam, prazepam, triazolam. (3) Non-barbiturates: paraldehyde. (4) Alcohols, chloral hydrate. (5) Propanediol carbamates: meprobamate, ethinamate. (6) Piperidinediones: glutethimide, methyprylon. (7) Quinazolines: methaqualone.

ALCOHOL

Inebriant poisons produce intoxication, i.e. light headedness, confusion, disorientation, and drowsiness, e.g. alcohol, barbiturates,. chloral hydrate, benzodiazipines, paraldehyde, anaesthetics, hydrocarbons, formaldehyde and many pesticides etc. In most cases there is recovery after prolonged sleep, with some after-effects (hangover), consisting of headache, irritability, lethargy, nausea and abdominal discomfort.

The term alcohol in common use refers to ethyl alcohol (C_2H_5OH). It is a transparent, colourless, volatile liquid, having a characteristic spiritous odour and a burning taste. Absolute alcohol contains 99.95% alcohol; rectified spirit contains 90% alcohol, and industrial methylated spirit or denatured alcohol is a mixture consisting of alcohol 95% and 5% of wood naphtha. Ethanol is produced by the fermentation of sugar by yeast. This process stops at an alcohol concentration of about 15% by volume, because of the death of the yeast. Alcoholic beverages are a mixture of alcohol and water with small amounts of congeners, which are simultaneously produced during the fermentation process. The characteristic flavours of alcoholic beverages are due to organic compounds called congeners, such as propyl alcohol, octyl alcohol, glycerin, aldehydes, dimethyl and diethyl esters, acids from acetic to linoleic, ketones, trimethyl amine, allyl mercaptan, diethyl sulphide, pyrozine, etc. The total content of congeners rarely exceeds half percent. The odour may persist in the tissues for several hours after all alcohol has been metabolised. "Proof spirit" is one which at 10.5°C weighs exactly 12/13 part of an equal measure of distilled water. Weaker spirits are termed "underproof" and stronger spirits "overproof". Proof is defined as twice the percentage of the alcohol content of the drink. The amount of alcohol consumed can be expressed in units; one unit being about 8 g. of alcohol. The approximate percentage of alcohol by volume in some of the more common beverages is as follows.

Vodka	: 60 to 65%
Rum, liquors	: 50 to 60%
Whisky, gin, brandy	: 40 to 45%
Port, sherry	: 20%
Wine, champagne	: 10 to 15%
Beers	: 4 to 8%

210 g of alcohol in men and 140 g of alcohol in women per week are considered safe limits for drinking, if liver damage is to be avoided.

Arrack : It is a liquor distilled from palm, rice, sugar or jaggery, etc., and has a strength of 40 to 50%. It may be mixed with chloral hydrate and potassium bromide for getting a greater kick.

ABSORPTION : Alcohol requires no digestion prior to absorption. Its small molecular size permits it to pass readily through membranes by simple diffusion. A small amount is absorbed from mouth and oesophagus. Absorption from the stomach and small intestine begins almost immediately upon ingestion. About 20% is absorbed from the stomach and 80% through small intestine. About 60% of diluted alcohol taken on empty stomach is absorbed in half-an-hour and 90% in one hour. Alcohol can be detected in the blood within 2 to 3 minutes of swallowing a few sips of whisky or beer. The maximum concentration in blood is reached within 45 to 90 minutes after ingestion with majority of persons reaching their maximum one hour after ingestion. Carbonated drinks hasten absorption, as the bubbles greatly increase the surface area carrying alcohol. Food delays its absorption, and the delay is most marked in the presence of fat and protein. A mixed meal can depress the maximum concentration of the blood alcohol by about half. Food

ingested with alcohol may prevent 10 to 20% of the ingested alcohol from being absorbed. Warm alcoholic drinks which dilate gastric mucosal capillaries are more quickly absorbed than iced drinks of the same strength. Persons with achloryhydria or chronic gastritis have slower absorption rates. Absorption is most rapid at concentrations of 10 to 20%. Lower and higher concentrations are absorbed more slowly. Dilute drinks, such as beer may take double the time to absorb compared to stronger drinks. Drinks containing more than 40% alcohol are absorbed slowly due to: (1) Pyloric spasm. (2) Irritation of gastric mucosa, and secretion of mucus. (3) Reduced gastric motility. Habituated heavy drinkers absorb alcohol more rapidly than abstainers, probably due to more rapid emptying time of the stomach and thus the rate of absorption. Drugs, e.g., benzine or atropine, may slow the rate of absorption of alcohol probably by retarding the emptying time of stomach. Alcohol is absorbed rapidly in cases of gastrectomy. If the concentration of alcohol in the air is too high, the irritating properties of the alcohol make breathing difficult or impossible. About 60% of alcohol inhaled can be absorbed into systemic circulation. Tolerable concentrations in the air are so low that intoxication by inhaling alcohol vapour is unlikely, since it is eliminated more rapidly than it is absorbed by this route. Alcohol is poorly absorbed through intact skin.

DISTRIBUTION : Some alcohol is lost by diffusion into the alveolar air, as the arterial blood passes through the lungs. In arterial blood, the concentration of alcohol further decreases due to passage through the capillary network. Alcohol is lost from the blood to the tissues in proportion to the water content of the tissues with which it comes in contact, till equilibrium is reached between the blood and tissues, except adipose tissues, as ethanol is insoluble in fat. Red cells contain less alcohol than plasma, so that a whole blood concentration is slightly less than that in separated plasma or serum. A given intake of alcohol will produce a higher blood alcohol level in obese persons as compared to the lean persons of the same weight, as the aqueous compartment is smaller. Ethanol is distributed evenly throughout the body water, passing the blood-brain barrier easily. It is poorly soluble in body fat and as such females of the same body weight will have a higher (25% higher) blood alcohol concentration for the same amount of drink, as their aqueous compartment is smaller. Venous blood alcohol in the absorption phase is about 10% lower than arterial blood. This accounts for a higher concentration of alcohol in alveolar breath compared to venous blood. One hour or more after drinking, venous blood contains the same concentration of alcohol. Capillary blood alcohol, and the ratio between the concentration of alcohol in arterial blood and brain, becomes constant in one to two minutes. Equilibration in muscle may require one to two hours.

Table (30–1) Relative concentration of alcohol at equilibrium

Sample	Relative concentration
Whole blood	1.00
Plasma or serum	1.12 to 1.2
Brain	0.85
Spinal fluid	1.1 to1.27
Vitreous	1.2
Urine	1.3
Liver	0.85
Alveolar air	0.0021

EXCRETION : Alcohol is excreted through all the routes of excretion. About 5% of ingested alcohol is excreted in the breath and about 5% in the urine. Negligible amounts are excreted in the sweat, saliva, milk, tears and faeces. The peculiar odour of the alcohol is due to the excretion of alcohol by the skin glands.

METABOLISM : As soon as ethanol enters the blood, the body starts to dispose it of by metabolism and excretion. About 90% of alcohol absorbed is oxidised in the liver, and the remaining 10% is excreted. In the liver, alcohol is oxidised to acetaldehyde by alcohol dehydrogenase (ADH) and its coenzyme, nicotinamide adenine-dinucleotide (NAD). In the second step, acetaldehyde is transformed into free acetic acid or its activated form, acetyl coenzyme A. Finally the acetate enters the general pool, and undergoes oxidation to CO_2 and water in the citric acid (Krebs) cycle. Acetate can form glycogen, proteins and possibly fats and cholesterol. The diabetic who is ketogenic will produce fat from alcohol, because he cannot use the sugar. The amount of enzyme can be increased through the regular use of alcoholic beverages, and the rate of alcohol decrease may be almost double. Large doses of fructose increase the rate of metabolism. During its oxidation, alcohol is not stored in the tissues. It disappears from the blood at a fairly uniform rate of about 10 to 15 ml. per hour. This is the equivalent of about 15 mg 100 ml. from the blood per hour. Larger doses are lost rather faster. Chronic alcoholics are able to metabolise alcohol at a faster rate, 40 to 50 mg./100ml./hour, than the non-alcoholics, due to an increase in liver enzymes, until they develop severe liver damage. Many chronic alcoholics develop liver damage and their rate of alcohol metabolism is

Table (30–2) Physiological effects of alcohol

Blood alcohol concentration	Effects
0 to 50 mg %	No significant effect or mild euphoria.
50 to 100 mg%	Decreased inhibitions, increased self-confidence, decreased attention span, slurring of speech, mild incoordination, alteration of judgement, nystagmus.
100 to 150 mg %	Some mental confusion, emotional instability, loss of critical judgement, ataxia, impaired memory, sleepiness, slowed reaction time.
150 to 300 mg%	Loss of muscular coordination, staggering gait, marked mental confusion, drowsiness, exaggeration of emotions, dizziness, decreased pain response, disorientation; thickened speech.
300 to 400 mg%	Stupor, marked incoordination, marked decrease in responses to stimuli, possibly coma.
400 mg % & above	Anaesthesia, depression of responses, respiratory failure, deep coma, death.

depressed, due to which they remain intoxicated for hours after a few drinks. 10% of metabolised alcohol is deposited in the tissues as lipids in the form of cholesterol and neutral fat.

ACTION : Traces of ethyl alcohol are found in all persons. Endogenous alcohol is partly due to normal metabolism and partly due to bacterial activity in gastrointestinal tract. Alcohol is a well-known stimulant, but is a selective depressant, especially of the higher nervous centres which it inhibits. Ethanol depresses primarily reticular activating system. The frontal lobes are sensitive to low concentrations (resulting in mood changes) followed by the occipital lobe (visual disturbances) and cerebellum (loss of coordination). Alcohol acts on neural cells in a way similar to hypoxia and reduces their activity. In lower concentrations, it causes depression of more specialised and sensitive cells of the cerebral cortex (centres regulating conduct, judgement and self-criticism), with release of their inhibitory tone, and leads to unrestrained behaviour. Increasing concentrations, progressively depress brain functions. Finally, the vital centres in the midbrain and medulla are depressed, which may cause death from cardio-respiratory failure. It causes generalised vasodilatation, especially in the skin. It is not a true aphrodisiac. It is a hypnotic and diaphoretic. It creates a sensation of warmth, but it increases heat loss. In moderation, it stimulates appetite as it promotes salivation and the secretion of gastric juice, but the stronger beverages have a reverse effect. A little brandy has a carminative action. Diuresis occurs secondary to inhibition of antidiuretic hormone release from the posterior pituitary. Spiritous liquors on an empty stomach can cause severe, even haemorrhagic gastritis.

Ethanol has toxic effects on almost every organ system. Some of the toxic effects can be related to effects of the metabolite acetaldehyde or to change in the redox potential of cells, but the mechanism by which ethanol causes intoxication is not specifically known. Although every neurotransmitter system is affected by ethanol, there do not appear to be specific receptors for ethanol.

Acute intoxication may block the metabolism of and lead to increased levels of drugs such as aspirin, benzodiazipines, barbiturates, tricyclic antidepressants, and phenytoin. It has synergistic effects with other sedative-hypnotic agents.

Moderate (15 to 30 g. per day) consumption increases concentration of HDL and decreases LDL. It has favourable effects on haemostatic factors, such as plasma fibrinogen, fibrinolytic activity and platelet adhesiveness.

"Mixing of drinks" is said to produce greater intoxication, than would be expected from the amount consumed. This may be due to the presence or formation of substances which affect the rate of emptying of the stomach, with more rapid absorption of the alcohol. Normal fasting blood alcohol concentration is less than 0.001 mg%. The old Roman saying, "IN VINO VERITAS", which means, "in wine there is truth", has a high degree of accuracy. In other words, the real personality of an individual often will be revealed when he is intoxicated.

Cause of Death : Death is caused either by the direct depressive effects upon the brain stem, mediated via the respiratory centre, or due to aspiration of vomit. Deaths due to acute overdose of alcohol are not common, but deaths due to the chronic effects of alcohol are common.

Symptoms : Serious acute alcohol poisoning is

usually a consequence of deliberate heavy drinking, either small doses at short intervals, or a large dose at a time. There are three phases of intoxication.

(1) Stage of Excitement : There is first a feeling of well-being and a certain slight excitation. The actions, speech and emotions are less restrained due to lowering of the inhibition normally exercised by the higher centres of the brain. There is increased confidence and a lack of self-control, which is a constant feature of alcoholic poisoning. The person may disclose secrets. Normal good manners are forgotten. The neat and orderly are careless in their dress. At blood alcohol concentrations of 30 mg%, impairment of cognitive function, motor co-ordination and sensory perception occur. Beyond 50 mg%, slurring of speech, unsteadiness, drowsiness, impaired reasoning and memory, reduced perception and decreased concentration occur. Alcohol reduces visual acuity in concentration as low as 20 mg% in abstainers, 20 to 33 mg% in moderate drinkers, and 40 to 70 mg% in heavy drinkers. Significant effects on judgement and motor control may occur with blood alcohol concentration (BAC) of 25 to 50 mg%. Strong light is often needed to distinguish objects, and dimly lighted objects may not be distinguished at all. It takes longer to see clearly again after being dazzled by a strong light. It alters time and space perception, e.g., the person may underestimate the speed of objects and distances travelled. The pupils are dilated. When jerking movement is in the direction of the gaze and independent of the position of the head, it is known as **alcohol gaze nystagmus** and appears at blood levels of 40 to 100 mg.% (average 80 mg.%). It is not a constant or common sign. Mental concentration is poor and judgement impaired. The faculty of attention deteriorates rapidly. Recall memory is often markedly disturbed, in which the person cannot accurately recall certain situation, or even names of individuals whom he has known for years. The reaction time of individuals becomes impaired. The emotions are affected. Alcohol increases the desire for sex, but markedly impairs the performance, often resulting in prolonged intercourse without ejaculation. These effects are usual between 50 to 150 mg.% of blood alcohol.

(2) Stage of Incoordination : When the alcohol content of the blood attains a level of 150 to 250 mg/100 ml., the sense perception and skilled movements are affected. The increased loss of the inhibitory action of the higher centres causes an alteration in the conduct of the individual. He may become carefree, cheerful, ill-tempered, irritable, excitable, quarrelsome, sleepy, and so on, according to the dominant impulses which have been released. There is certain clumsiness and incoordination in the fine and more skilled movements, as shown by slight alteration in speech and in the fine finger movements. Nausea and vomiting are common. The breath smells of alcohol. The face is flushed and the pulse is rapid. Sense of touch, taste, smell, and hearing are diminished. The temperature becomes subnormal. Heart rate is increased.

(3) Stage of Coma : In this stage, the motor and sensory cells are deeply affected, speech becomes thick and slurring, coordination is markedly affected, causing the patient to become giddy, stagger and possibly to fall. The person passes into a state of coma with stertorous breathing. The pulse is rapid and temperature subnormal. The pupils are contracted, but stimulation of the person, e.g. by pinching or slapping, causes them to dilate with slow return (**Mc Ewan Sign**).

MICTURITION SYNCOPE is a condition which occurs usually after heavy beer drinking. When the person rises from bed in the middle of night to pass urine, he loses consciousness during the act of urination, probably due to sudden upright posture.

MUNICH BEER HEART is a condition in which cardiac dilatation and hypertrophy is seen due to excessive and prolonged beer drinking.

With recovery, the coma gadually lightens into a deep sleep, and the patient usually recovers in 8 to 10 hours, and wakes up with acute depression, nausea, abdominal discomfort, irritability, lethargy, and severe headache (**Hangover**). If coma continues for more than five hours, the prognosis is likely to be worse. Death occurs from asphyxia due to respiratory paralysis, but it may occur from shock. Most deaths from alcoholic intoxication do not occur at peak blood levels, but occur some hours later after irreversible damage has been done to vital centres.

In acute alcoholic intoxication, death may occur with blood alcohol concentration of less than 400 mg%, in persons with chronic debilitating diseases, especially severe arteriosclerotic heart disease and pulmonary emphysema. Chronic lung disease and conditions associated with varying degrees of hypoxia may also cause death in the presence of relatively low levels of alcohol.

Prolonged coma due to alcohol may cause

irreversible hypoxic brain damage and death. In such cases blood alcohol level is usually low, as some or even all of the alcohol in the body may have been oxidised and excreted. Low levels are also seen if the person survives for several hours after excessive drinking.

Fatal Dose : 150 to 250 ml. of absolute alcohol consumed in one hour.

Fatal Period : 12 to 24 hours.

Tolerance to Alcohol : It is acquired and may be lost by those 'out of practice'. It is restricted by liver damage. A person in the habit of taking alcohol daily can drink alcohol without getting 'drunk' in quantities which would seriously affect a person unaccustomed to taking it. Tolerance may be a matter of tissue sensitivity, or of the rate of absorption. Barbiturates are metabolised via the same route; however in the presence of alcohol which is preferentially metabolised, they remain active longer.

Consent for Examination : The consent of the detained person to medical examination is necessary. If the person is unconscious, or otherwise not in a fit condition to give consent, the doctor called by the police should not disclose to the police any information he obtained during his examination, but should wait to get the consent of the patient when he regains consciousness, or is in a fit condition to be asked.

Treatment : (1) Evacuation of the stomach and bowel and gastric lavage with an alkaline solution usually causes a diminution in the symptoms. (2) The patient must be kept warm, and if there is congestion of the brain, ice bags should be applied to the head. (3) One litre of normal saline with 10% glucose, 100 mg. thiamine and 15 units of insulin are useful. (4) If the coma deepens, nerve stimulants, such as caffeine and strychnine should be used and artificial respiration, if there is difficulty in breathing. (5) Inhalation of oxygen is of great value. (6) Haemodialysis or peritoneal dialysis is very useful.

Post-mortem Appearances : On opening the cavities of the body, alcoholic odour is frequently noted. Acute inflammation of stomach with a coating of mucus is commonly found. The brain, liver and lungs are congested, and the smell of alcohol in the viscera may be noted. The blood is usually fluid and dark. Oedema and congestion of the brain and meninges and cloudy swelling of parenchymatous organs are seen.

Chronic Poisoning : **Alcohol addicts** are people who cannot stop drinking for long, or who experience withdrawal symptoms, if they do. It results in impaired social or occupational functioning. **Chronic alcoholics** are those who have reached a state of more or less irreversible somatic or brain changes caused by alcohol. The patient suffers from nausea, vomiting, anorexia, diarrhoea, jaundice, tremors of the tongue and hands, insomnia, loss of memory, impaired power of judgement, hypoproteinaemia and general anasarca. The symptoms of peripheral neuritis and dementia occur in the last stage. Such patients generally die suddenly from coma.

Post-mortem Appearances : The gastric mucous membrane is deep reddish-brown with patches of congestion or effusion and is hypertrophied. The liver is congested and shows fatty infiltration, enlarged or cirrhotic or contracted. The kidneys show granular degeneration. The heart is dilated and shows fatty degeneration.

Precautions in collection of specimens: (1) Use clean containers with adequate preservative. (2) Refrigerate samples while storing. (3) Obtain samples with a clean needle and syringe from the femoral or subclavian vessels. Alcohol can diffuse after death through the gastric wall into the blood in the heart and great vessels. Take samples from more than one area as postmortem diffusion is a possibility. (4) Spinal fluid and vitreous humour are very good samples. (5) Do not take samples from pericardial sac or from the chest cavity. (6) Do not use contaminated needles, syrings or containers. (7) Do not use spirit for cleaning the skin, before obtaining blood sample. In embalmed bodies alcohol is estimated on either vitreous or muscle.

Treatment : (1) Disulfiram (Antadict, Esperal) is given in a single daily dose of 250 mg. The dosage is gradually reduced until an adequate daily dosage of 0.125 to 0.25 g. is reached, which should be continued until the patient has been conditioned to accept adequate follow-up therapy. Antabuse (tetraethylthiuram disulfide) inhibits the biotransformation of ethanol beyond the acetaldehyde stage. Ethyl alcohol is metabolised by the liver as two step process : (1) Conversion of alcohol to acetaldehyde in the presence of NDA (nicotinamide adenine dinucleotide) and alcohol dehydrogenase, and (2) oxidation of the acetaldehyde to carbon dioxide and water or combining of the acetaldehyde as a two-carbon fragment into acetyl COA. Antabuse

partially block reaction 2, leading to accumulation of acetaldehyde in the blood and tissues and causes unpleasant symptoms, such as flushing, palpitation, anxiety, sweating, headache, abdominal cramps, nausea and vomiting, due to which the patient dislikes alcohol. (2) Citrated calcium carbimide (Temposil) 50 mg. tablet once a day can be used with less side-effects. (3) Chlopromazine 25 to 50 mg. every 4 to 6 hours is also useful. (4) Clonidine 60 to 180 mg/hr i.v. (5) Chlormethiazole.

The Conditioned Reflex Treatment : It consists of giving alcoholic beverages to the patient in surroundings that affect his visual and olfactory senses. With a backdrop of bottles of various alcoholic beverages, the patient is given various types of liquor, together with drugs that will cause immediate and acute nausea and vomiting. After 5 to 8 daily treatments, symptoms are brought on simply by the sight of a bottle, and the patient begins mentally to associate his painful sickness with the alcohol. Hypnosis and psychotherapy are also useful.

Alcoholics Anonymous is an international voluntary organisation which has branches throughout India. The addicts who are desirous to give up alcohol narrate their bad experiences to other alcoholics through group meetings, letters, press and other media. The organisation functions on a self-supporting basis through contribution from the members.

DRUNKENNESS

Drunkenness is a condition produced in a person, who has taken alcohol in a quantity sufficient to cause him to lose control of his faculties to such an extent, that he is unable to execute safely, the occupation in which he was engaged at the particular time.

The clinical diagnosis depends on the combination of a number of symptoms and signs, no single one of them being peculiar to this condition, except the odour of alcohol from the breath. An individual can react differently under different circumstances, and that the same amount of alcohol can produce different effects on different people under the same circumstances. Mentally unstable subjects, epileptics and those who have suffered cerebral trauma at some earlier date may show an excessive reaction to small amounts of alcohol.

A Model Scheme of Medical Examination: The scheme of examination of an alleged alcoholic has been suggested by the Special Committee of the British Medical Association, "The Drinking Driver", 1965. The medical examiner's record should include a note of the date and of the time at the beginning and at the end of the examination.

(1). Exclusion of Injuries and Pathological States: The following conditions which simulate alcoholic intoxication should be excluded : (a) Severe head injuries. (b) Metabolic disorders, e.g. hypoglycaemia, diabetic pre-coma, uraemia, hyperthyroidism. (c) Neurological conditions, e.g. disseminated sclerosis, intracranial tumours, Parkinson's disease, epilepsy, acute aural vertigo. (d) Drugs : Insulin, barbiturates, antihistamines, morphine, atropine, hyoscine. Drugs capable of producing sedation or depression of the nervous system (antihistaminics, tranquilisers), will simulate or enhance the effects of alcohol. (e) Certain pre-existing psychological disorders, e.g. hypomania, general paresis. (f) High fever. (g) Exposure to CO.

(2) History : The history of the relevant events should be obtained from the accused person while observing him. Enquire whether he suffers from any disease or disability and whether he is under medical treatment.

(3) General Behaviour : (a) General manners and behaviour. (b) **State of dress** : Presence of slobber on mouth or clothing ; presence, character and colour of any vomit, soiling of clothes by excretions. **(c) Speech** : Note the type, e.g. is it thick, slurred or over-precise? Slight blurring of certain consonants is one of the earliest signs of incoordination of the muscles of the tongue and lips. Certain test phrases may be used to bring out this difficulty in speech, such as 'British Constitution', 'West Register Street', 'Truly Rural', etc. A sober person will say that he is not good at such phrases; the semi-intoxicated person will often insist on getting them correctly. **(d) Self-control.:** Note whether he is able to control himself in response to the demands made on him by the examiner.

(4) Memory and Mental Alertness : The memory of the person for recent events, and his appreciation of time can be judged by asking suitable questions about his movements during the preceding few hours, and the details of his accident if any. A few very simple sums of addition or subtraction may be asked.

(5) Handwriting : The examinee should be

asked to copy a few lines from a newspaper or book. A note should be made of : (a) The time taken. (b) Repetition or omission of words, letters, or lines. (c) Ability to read his own writing. Both the original and the copy should be retained. The examinee should be asked to sign his name. The signature can be compared with that on his driving license if any.

(6) Pulse : The resting pulse should be taken at the beginning and at the end of the examination. The pulse is rapid and is usually full and bounding. A slight increase in B.P. may occur, often in the systolic level.

(7) Temperature : The surface temperature is usually raised.

(8) Skin : Note whether skin is dry, moist, flushed or pale.

(9) Mouth : (a) Record the general state of mouth, teeth and tongue, noting whether the tongue is dry, furred or bitten. (b) The smell of the breath should be recorded.

(10) Eyes : **(a) General appearance :** (1) Whether the lids are swollen or red, and whether the conjunctivae are congested. (2) The colour of the eyes, and abnormalities.

(b) Visual acuity : Any gross defect should be noted.

(c) Intrinsic muscles : (1) Pupils : Equal or unequal, dilated or contracted or abnormal in any way(usually dilated in early stages, but may be contracted in later stages or coma). **(2) Reaction to light :** Note whether the action is brisk, slow or absent. They may become unequal, equalising again in response to light, and dilate again slowly even if the light continues to be directed into the eyes.

(d) Extrinsic muscles : (1) Convergence : Test the degree of ability to follow a finger in all normal directions and to converge the eyes normally on a near object. **(2) Strabismus :** Note whether it is present. **(3) Nystagmus** : The presence of fine lateral nystagmus may indicate alcoholic intoxication. Nystagmus may be produced by fatigue, emotion or postural hypotension.

(11) Ears : Examine for (a) Gross impairment of hearing. (b) Abnormality of the drums.

(12) Gait : The integrity of the nervous and muscular system is tested for the coordination of fine and gross movements, e.g. balance, gait and speech. The examinee should be asked to walk acorss the room and note: (a) **Manner of walking:** Is it straight, irregular, overprecise, unsteady, or with feet wide apart? (b) **Reaction time to a direction to turn :** Does the examinee turn at once or continue for one or two steps before obeying? (c) **Manner of turning :** Does the examinee keep his balance, lurch forward, or reel to one side? Does he correct any mistake in a normal or exaggerated way? It is undesirable to ask the examinee to walk along a straight line drawn on the floor.

(13) Stance :Note whether the examinee can stand with his eyes closed and heels together without swaying.

(14) Muscular Coordination : Ask the examinee to perform the following tests: (a) Placing finger to nose. (b) Placing finger to finger. (c) Picking up medium-sized objects from the floor. (d) Lighting a cigarette with a match. (e) Unbuttoning and rebuttoning coat. (f) Lifting two objects, such as tumblers from the table, and replacing them side by side on the table.

The examiner should not ask the examinee to perform any act which he could not perform easily himself. He should also appreciate the difficulty involved for some people in apparently simple movements, such as picking up small objects from the floor. A chronic alcoholic when sober may not be able to perform tests for coordination as well, as when he has actually consumed alcohol.

(15) Reflexes : Knee and ankle reflexes should be tested which are delayed or sluggish. Plantar reflex may be extensor or flexor.

(16) Pulmonary, Cardiovascular and Alimentary Systems : The heart, lungs and abdomen should be examined, and the blood pressure taken to establish the presence or absence of disease.

(17) Tests : Some of the following objective tests are useful; flicker fusion test, measurements of tremor during standing, oscillations during forced imbalance, pupillary reflex time, speed of spinal reflexes, presence of random ocular movements with closed eye, nerve conduction speed, complex reaction time, delayed auditory feedback, positional nystagmus, glare recovery test, colour difference threshold, etc.

(18) Laboratory Investigations : The degree of intoxication can be estimated by the concentration of alcohol in the blood, urine, breath, or saliva. In fatal accidents with partial body destruction, muscle or the fluid in the eye can be analysed. Vitreous humour and urine are protected from putrefactive

processes for a longer period of time and do not contain much glucose. Blood is the most suitable and the most direct evidence of the concentration of alcohol in the brain. The disadvantages are : (1) it may be difficult to collect from an uncooperative person, (2) consent of the person is necessary, (3) substances like acetone, ether, paraldehyde, etc. when present in the blood are estimated as alcohol.

URINE : Urine has about 25% more water than an equal volume of blood, so its concentration of alcohol would be about 25% higher than in blood collected at the same time. As the urine is secreted, its water will have essentially the same alcohol concentration as the water of the blood passing through the kidney. If the bladder contains urine before drinking began, urine secreted during or after the period will be diluted with the alcohol-free urine. If the bladder was empty when drinking began, urine secreted after some time will reflect the blood concentration of alcohol at that time. In order to compare the urine and blood, a ratio of 1.3:1.0 is usually accepted when urine and blood are in equilibrium. Analyses of two urine samples are required. The first sample should be taken as soon as possible following the incident, the bladder being completely emptied. The second sample should be taken 25 to 30 minutes later. The concentration of alcohol in the second specimen reflects the blood alcohol level during the inter-specimen interval. The difference in the alcohol concentrations in the two samples indicates whether the subject was in the absorptive phase, at its peak, or in the elimination phase. Multiplication of alcohol concentration in the second urine specimen by 0.75 (based on a blood-urine alcohol ratio of 1:1.35) gives an approximate value of the blood alcohol level, during the time that this specimen was being secreted. Extrapolation from this blood level back to the time of the incident indicates the extent of the individual's intoxication at the critical moment when the incident occurred. A urine sample taken post-mortem may be more reliable qualitative index of ante-mortem intoxication, than is blood. Simultaneous performance of post-mortem blood and urine alcohol analyses give useful information. If the post-mortem urine alcohol concentration exceeds that of the blood by more than 25%, it indicates that higher blood alcohol must have existed during life, than was found at autopsy.

Table (30–3) Blood alcohol in relation to alcohol consumed.

Amount of ethyl alcohol per 100 ml. of blood	Amount of ethyl alcohol in a man of 70 kg.	-Minimum amount of liquor consumed			Time required for complete removal of alcohol from body.
		Whisky 40%	Wine 16%	Beer 3.28 %	
50 mg.	26 ml.	68 ml.	172 ml.	0.8 Lit.	2.5 hours.
100 mg.	53 ml.	136 ml.	344 ml.	1.6 Lit.	5 hours.
200 mg.	106 ml.	275 ml.	688 ml.	3.2 Lit.	10.5 hours.
300 mg.	159 ml.	411 ml.	933 ml.	4.8 Lit.	16 hours.
400 mg.	212 ml.	550 ml.	1.38 Lit.	6.4 Lit.	21 hours.
500 mg.	264 ml.	687 ml.	1.62 Lit.	8.0 Lit.	26.5 hours.
600 mg.	318 ml.	825 ml.	1.87 Lit.	9.6 Lit.	32 hours.

Table (30–4) Mg% concentration of alcohol in blood in relation to amount consumed within one hour.

% of alcohol	10 cc.	20 cc.	30 cc.	40 cc.	50 cc.	60 cc.	70 cc.	80 cc.	90 cc.	100 cc.
100	10	32	48	64	80	96	112	128	144	160
90	14..20	28.40	42.60	56.80	71	85.20	99.40	113.60	127.80	142
80	12.40	24.80	37.20	49.60	62	74.40	86.80	99.20	111.60	124
70	10.60	21.20	31.80	42.40	53	63.60	74.20	84.80	95.40	106
60	8.70	17.40	26.10	34.80	43.50	52.20	60.90	69.60	78.30	87
50	6.80	13.60	20.40	27.20	34	40.80	47.60	54.40	61.20	68
40	5	10	15	20	25	30	35	40	45	50
30	3.20	6.40	9.60	12.80	16	19.20	22.40	25.60	28.80	32
20	1.30	2.60	3.90	5.20	6.50	7.80	9.10	10.40	11.70	13
10	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL

(Kothari, D.R., The Clinician)

If the post-mortem blood alcohol level equals or exceeds that of the post-mortem urine alcohol concentration, the subject was probably in the absorptive phase at the time of the death, and probably less than two hours had passed since he consumed his last drink.

The disadvantages of urine examination are: (1) A time lag before equilibrium between blood and urine is reached; the maximum concentration is reached about twenty to twenty-five minutes later than in blood. (2) The urine alcohol concentration at any given time after the maximum concentration in blood has been reached will be higher by 20 to 30% than in the blood, because the specimen of urine examined will have been seereted from the blood at some earlier period. (3) Alcohol may pass through the lining of the bladder in either direction both in life and after death, depending on the relative concentration of alcohol in blood and urine.

Collection of Blood : Spirit must not be used for cleaning the skin, and the syringe must be free from any trace of alcohol. The skin is cleaned with a soluion of 1:1000 mercuric chloride or washed with soap and water. Blood samples should be preserved by the addition of 100 mg. of sodium fluoride and 30 mg. potassium oxalate for 10 ml. followed by thorough shaking. This prevents loss of alcohol by glycolysis and bacterial action. Such samples will maintain their alcohol concentration for several weeks, even at room temperature. 50 mg. of phenyl mercuric nitrate or sodium azide can also be used, as a preservative for 10 ml. of blood or urine.

A screw-capped glass bottle of "universal" size is suitable. The container should be tightly clamped and sealed to prevent loss of alcohol by evaporation and labelled with name, date and time of taking specimens. Rubber stoppers should be avoided, because they may contaminate the sample with oxidisable substances. If they are not transmitted at once to the laboratory, they should be refrigerated but must not be frozen. Freezing will cause the cells to lyse. When blood is kept in a refrigerator, formation of oxidisable substances is not significant. Analysis is best made within a week. Serum or plasma alcohol concentration is 12 to 20% higher than that of whole blood.

Collection of Post-mortem Samples : In temperate climates, post-mortem blood alcohol determinations are completely valid for 36 hours after death. The best place to obtain blood is from femoral or iliac veins or from axillary veins. Jugular vein is not suitable as it may be contaminated by reflux from the upper thorax. If the concentration of alcohol is same in all these samples the exposure is extraneous, because bacterial and chemical decomposition does not occur at exactly the same rate all over the body. Free blood in the pleural or pericardial cavities should not be used as false high results may be obtained due to gastric alcohol diffusion after death.

In embalmed bodies alcohol can be estimated either in the vitreous or muscle.

Erroneous result can be obtained due to haemolysis, clot formation, post-mortem diffusion from other body fluids and tissues, not properly preserved sample, and putrefaction. False blood alcohol levels in excess of 0.1 mg.% may be produced if autopsy blood samples are stored at room temperature for more than a week.

Widmark evolved a formula which takes into account the size and sex of the person and the type of alcoholic liquor consumed. The formula is a = prc, where a, is weight of alcohol (in g.) in the body; p, is the body weight (in kg.); c, is the concentration of alcohol in the blood (in mg. per kg.) ; and r is a constant (0.6 for men and 0.5 for women (Table 30-3).

For urine analysis the formula is a=3/4 prq. q is the alcohol concentration (in mg.per kg.).

Table (30-4)has been constructed, using Widmark's formula. It shows the minimum blood consumption of 100 ml. or less of alcohol in various concentrations in finding out the concentration of alcohol in blood at different time intervals. By subtracting 15 mg% per hour from the blood alcohol concentration, it is possible to get values for the following hours, e.g. if a person consumes 100 ml. of 100% alcohol, his blood alcohol concentration would be 160 mg% at the end of one hour. The concentrations at the end of second, third and fourth hours would be 145, 130 and 115 mg. respectively. If the blood concentration at the time of collection is known, by addition of 15 mg. for evey hour the concentration at previous timings can be calculated, e.g., if the blood collected at 20.00 hrs. shows the alcohol concentration of 160 mg., the values at 19.00 hrs, and 18.00 hrs. would have been 175 and 190 mg% respectively.

Back calculations: The sex, size, obesity, the

drinking history, completeness of absorption, timing, amount and nature of meals taken, all alter the parameters of calculation. Wide margins of error (50 to 100 mg%) are possible. Back-calculations are unreliable and inaccurate. The rule of thumb is that 30 ml. of 80° proof liquor will raise blood alcohol concentration by 25 mg %.

Methods Used for Determining Blood Alcohol: Presumptive tests which measure the presence of any volatile reducing agent are routinely done. The basic principle is a reduction of potassium bichromate by the test substance. (1) **Kozelka and Hine** test is a macro-method. (2) **Cavett test** is a micro-method. Many procedures are employed for determining the values of ethyl alcohol, including head space and direct injection gas chromatography, enzyme-spectrophotometric assays and oxidation techniques. For medico-legal purposes, the most desirable is gas chromatography in which specificity can be ascertained.

Test: In a test tube place one ml of unknown solution + one ml of acetic acid + one drop of sulphuric acid and heat gently for one minute. Strong fruity odour is positive.

Breath : Breath analysis machines operate on the principle that alcohol absorbs radiation in the infrared region of the spectrum and that the amount of infrared light absorbed by a vapour is proportional to the concentration of alcohol in that vapour. 60 to 100 ml. of breath is received into a dry balloon and analysed by drunkotester, drunkometer, intoximeter, alcometer, alcotest or breathalyser. The end portion of a prolonged forced expiration gives correct results. The concentration of alcohol in deep lung air is dependent on that in arterial blood. 2100 to 2300 ml. of alveolar air contains the same amount of alcohol as one ml. of blood. This is based on **Henry's law,** which states that when a volatile chemical (ethanol) is dissolved in a liquid (blood) and is brought to equilibrium with air (alverolar air), there is a fixed ratio between the concentration of volatile compound (ethanol) in air (alveolar air) and its concentration in the liquid (blood), and the ratio is constant at a given temperature. (i.e. in alcohol 34°C, i.e. temperature of breathed out air). The converted breath tests are in close agreement with those obtained by direct blood analyses. The person is asked to blow into a plastic balloon through a glass tube. Recently developed breath analysers rely on infrared absorption of energy by ethyl alcohol vapour in breath samples. It is a direct method which instantly measures breath alcohol quantitatively. The residual alcohol in the mouth disappears in 20 minutes. As such, the test should be repeated after 20 minutes. More sophisticated instruments based on fuel-cell sensing, electrochemical oxidation, infrared photometry and micro-processors accurately predict blood alcohol concentration.

Many factors can temporarily upset the reliability of breath analysis, such as sternuous hyperventilation, violent physical exercise, emesis and regurgitation of stomach contents, eructation or belching and drinking of liquor within few minutes of the time of the performance of the test. Under these conditions false values are obtained. Plastic, aluminium and other metal flexible bags have been developed, so that breath samples may be preserved for several hours with minimum loss of alcohol. Breath alcohol levels rise faster and fall earlier than venous blood alcohol levels. The estimation of the stage of alcohol absorption, distribution or elimination can be made from analysis of two or more serial specimens from the same individual at known intervals of time.

Saliva : Mouth should be thoroughly washed with water and about 5 ml. of saliva collected in a test tube containing 10 mg. of sodium fluoride.

Vitreous: At equilibrium, for every unit of alcohol in blood, there are 1.2 units of alcohol in vitreous, as it has a high water content. During the absorptive phase of alcohol, vitreous alcohol levels are lower than in the blood. Vitreous alcohol lags behing blood alcohol by 1 to 2 hours. It does not change after death due to putrefaction.

The Diagnosis : There are usually no difficulties in the diagnosis in extreme cases, i.e., where the person is clearly drunk or clearly sober. Problems arise in the marginal case, and in those with intermediate degree in the disturbance of behaviour. The usual signs of drunkenness are : strong odour of alcohol in breath, loss of self-control and clearness of intellect, unsteady gait, vacant look, congested eyes, sluggish and dilated pupils, dry lips, increased pulse rate, unsteady and thick voice, talks at random and lack of perception of passage of time. Determination of blood alcohol helps: (1) to know the concentration of alcohol circulating in the body, (2) to determine within fairly wide limits how much alcohol must have been imbibed within a certain period of time. This can be attempted only after

equilibrium between the blood and tissues has been attained, which can help the Court in testing the reliability of the statements of the accused, (3) to assist the doctor in confirming his suspicions, (4) enable the Court to accept clinical diagnosis, (5) serve to resolve conflicting reports given by non-medical witnesses. There is a large variation in the susceptibility of drinkers to the effects of alcohol. Young person, or those unused to drinking will be affected by much lower levels of blood alcohol than the average, whereas alcoholics show tremendous tolerance to the effects. The effects of acute alcohol intoxication are more marked when the blood level is rising than falling.

The individual psychological reaction to acute alcohol intoxication is variable. It has been established that some individuals remain sober at a very high blood alcohol level. A person may be intoxicated at a low blood alcohol level, but at another time he may be diagnosed as sober at very high levels. A chronic alcoholic with a blood level of 50 mg% may appear sober though there is impairment in the reflexes, visual acuity, memory, concentration, and judgement. Therefore, the blood alcohol level is only one item in the evidence, which must be considered in relation to other evidence about the behaviour of the person at the material time. This evidence may be medical as well as non-medical. (1) The medical examination is extremely subjective, many of the observations made are incapable of objective or quantitative record. (2) There is individual variation from one clinical examiner to another. (3) As the medical examination is usually conducted some considerable time after the accident, it will be very difficult for the doctor to dogmatise about the accused's condition and capacity at the time of accident. (4) If an arrested person suffers from fear or acute anxiety often complicated by fatigue states, the signs may simulate drunkenness. Non-medical evidence about the conduct of the person concerned may be very important, and may be considered by the Court regarding the diagnosis as it may indicate the nature of the behaviour at the time of arrest. The blood alcohol level is only of value when it is consistent with other non-chemical observations made.

Medical Terminology : "Under the influence" means that due to drinking alcohol, a person has lost (to any degree), some of the clearness of the mind and self-control that he normally possesses. Loss of judgement and the capacity for self-criticism occur long before the obvious symptoms of intoxication. All individuals with a blood alcohol level of 140 mg% are intoxicated to the point where they cannot deal with unusual, emergency or non-customary problems.

Below 10 mg: Sober.
20 to 70 mg% : Drinking.
80 to 100 mg % : Under the influence.
150 to 300 mg% : Drunk or intoxicated.
400 mg% and above : Coma, and death.

Under the influence: The symptoms are: flushed face, dilated and sluggish pupils, euphoria, loss of restraint, thickness of speech, carelessness and recklessness, incoordination, stagger on sudden turning.

Drunk: The symptoms are: flushed face, dilated and inactive pupils, rapid movement of eye balls, unstable mood, loss of restraint, clouding of intellect, thickness of speech, incoordination, staggering gait with reeling and lurching when called upon to make sudden turns.

Very drunk: The symptoms are: flushed or pale face, pupils inactive, contracted or dilated, mental confusion, gross incoordination, slurred speech, staggering, reeling gait, tendency to lurch and fall, vomiting.

Coma: The symptoms are: rapid pulse, subnormal temperature, stertorous breathing, deep unconsciousness, contracted pupils.

HAZARDS OF ALCOHOL : Fatal acute poisoning by alcohol is rare, but mild and moderate degrees of intoxication are frequent and create a social and medical problem. Alcohol is associated with domestic violence, child abuse and suicide. The personal risks are : (1) He may die of exposure. (2) Alcohol in the tracheobronchial tree can cause pneumonia. (3) Inhale his vomit or dentures. (4) A bolus of food or meat inhaled into larynx can cause death due to choking. (5) Alcohol reduces man's resistance to the effects of hypoxia. This makes alcohol a hazard to those engaged in mountain climbing, aviation, and in any person who has a cardiac or pulmonary condition with borderline hypoxia. (6) He may fall and sustain a head injury. (7) He may fall into water and be drowned. (8) He may turn on the gas and forget to light the burners. (9) He may electrocute himself when fumbling with a plug or a defective electrical circuit. (10) He may take poison by mistaking it for alcohol. (11) An intoxicated person driving motor vehicle is a grave danger to others. (12) The so-called SATURDAY NIGHT PARALYSIS occurs in the stage of coma, and results from pressure on a nerve trunk, as when an arm hangs over a chair (pressure on the radial nerve).

Alcoholic Palimpsests (alcoholic blackout): It

is a condition seen among alcoholics, and rarely in the non-addictive drinker, after drinking a moderate amount of alcohol. The behaviour resembles the 'blackouts' in anoxaemia. This may result in the loss of memory of a period during a drinking spell, or in some cases, the inability to recall what happened over a period of days. Amnesia can be fragmentary or total. In the latter case, the memory with regard to the "lost time", is unlikely to return. It is a late manifestation of alcoholism. During such state, the person may perform a criminal act, and may not remember this after he recovers from the effects of intoxication.

Alcohol and Traffic Accidents : There is progressive loss of driving ability as blood alcohol concentration rises. The safe driving is interfered due to : (1) It increases reaction time. (2) It creates false confidence. (3) It impairs concentration, dulls judgement, and degrades muscular coordination. (4) It decreases visual and auditory acuity.

Below 50 mg.% concentration of blood alcohol, majority of drivers are not affected, as regards road safety. Tasks which require control of speed and sensorimotor coordination in keeping a vehicle on its course and braking is impaired at 50 mg%. The driver experiences an increase in boldness and impulsiveness. This results in a tendency to drive faster and more erratically. At 60 mg%, the driver of a vehicle is twice as likely to be involved in an accident as compared to a sober driver. Risk of accident begins to increase markedly at 80 mg%; by 100 mg% risk is 12-fold and at levels of over 150 mg%, this becomes 20 times more likely. At or before 100 mg%. all individuals are affected, and accidents are common. At levels of 150 mg. percent driving becomes distinctly impaired. Drivers under the influence genuinely believe that they are driving better than they are.

In some countries, the law has made it an offence for a person to drive a motor vehicle above a specified blood alcohol level, e.g. 20 mg% in Poland and Sweden, 50 mg% in Norway, 80 mg % in U.K., France and 100 to 150 mg% in different States of U.S.A The statutory limit in India is 30 mg% (S.185, Motor Vehicle Act, 1988). The punishment for first offence is fine up to Rs. 2,000 or 6 months imprisonment or both, and for a second or subsequent offence fine up to 3000 or imprisonment up to 2 years or both.

Many drugs affect driving, such as tranquillisers, opiates, barbiturates, cannabis, hallucinogens, anti-histaminics, anti-depressants and anti-psychotics.

Alchol Withdrawal: Symptoms appear 12 to 48 hours after reduction in alcohol intake. The essential feautres are a coarse tremor of the hands, tongue and eyelids in association with at least one of the following: (a) nausea and vomitig, (b) malaise and weakness, (4) hypertension, tachycardia and sweating, (d) anxiety, depressed mood and irritability, (3) transient hallucinations and illusions, (f) headache and insomnia. Withdrawal seizures are typically single and generalised and usually develop 6 to 48 hours after last drink. About one-third of these patients will develop delirium tremens unless preventive measures are taken.

Treatment: 20 mg of chlordiazepoxide, or 100 mg of diazepam, are given four times a day.

Pathology : (1) Delirium Tremens : This results from the long continued action of the poison on the brain. It occurs in chronic alcoholics due to (1) temporary excess, (2) sudden withdrawal of alcohol, (3) shock after receiving an injury, such as fracture of a bone, or (4) from acute infection, such as pneumonia, influenza, erysipelas, etc.

It typically begins 72 to 96 hours after the last drink. There is an acute attack of insanity in which the main symptoms are coarse muscular tremors of face, tongue and hands, insomnia, restlessness, loss of memory, agitation, confusion, disorientation, uncontrollable fear and has tendency to commit suicide, homicide or violent assault or to cause damage to property. Other symptoms are diarrhoea, dilated pupils, fever, tachycardia, tachyapnoea, and hypertension. There is disorientation as to time and place, and a peculiar kind of delirium of horrors owing to hallucinations of the sight and hearing. The patient imagines that insects are crawling under the skin, or snakes are crawling on his bed. It is considered unsoundness of mind, and not intoxication. Death occurs in about 5 to 15% of cases. To control agitation diazepam should be given.

(2) ALCOHOLIC POLYNEURITIS AND KORSAKOFF'S PSYCHOSIS : The symptoms of polyneuritis are weakness, pain in the extremities, wrist and foot drop, unsteady gait, loss of deep reflexes and tenderness of muscles of arms and legs.

(3) ALCOHOLIC PARANOIA : In this there are fixed delusions but no hallucinations. The person becomes deeply suspicious of the motives and actions of those he meets and of his family members.

(4) ACUTE ALCOHOLIC HALLUCINOSIS :

Persistent hallucinations develop within 48 hours after cessation of alcohol intake. The hallucinations may be auditory or visual and their content is usually unpleasant and disturbing. The disorder may last several weeks or months.

(5) ALCOHOLIC EPILEPSY: Seizures occur after a day or more of the termination of a drinking session. Sometimes, the attacks may occur while the patient is actually drinking.

(6) WERNICKE'S ENCEPHALOPATHY: This results from a hypothalamus, midbrain and cerebellum lesion due to heavy drinking, Vitamin B_1 deficiency occurs.

Symptoms include disturbance of consciousness, drowsiness, amnesia, peripheral neuropathy, external ocular palsies, ophthalmoplegia, nystagmus, ataxia, delirium and stupor. It has a high mortality and can cause death in 24 hours. If untreated about 80% cases progress to a more chronic condition known as Korsakoff psychosis, in which impairment of anterograde and retrograde memory, severe disorientation in time, with inability to learn new information and confabulation (recitation of imaginary experiences to fill gaps in the memory) are seen.

(7) CARDIAC DYSRHYTHMIAS: In alcohol withdrawal tachyrhythmias are common probably because of high adrenergic nervous system activity, which may cause sudden death.

(8) MARCHIAFAVA'S SYNDROME: Degeneration of the corpus callosum may occur in alcoholics.

(9) MALLORY-WEISS SYNDROME : Ruptured oesophagus with mediastinitis occurs.

(10) Malnutrition.

(11) Gastric and peptic ulcer.

(12) Cirrhosis.

(13) Myocarditis.

(14) Pancreatitis.

(15) Mental illness. Depression and high risk for suicide.

(16) Alcohol creates a disturbance in tryptophane metabolism. Conversion of tryptophane to 5-hydroxyindolacetic acid (the urinary metabolite of serotonin) is depressed in the chronic alcoholic.

ALCOHOL AND CRIMINAL BEHAVIOUR: A strong relationship exists between the abuse of alcohol and the occurrence of accidents and acts of violence. The crimes most frequently indulged are those activated by the passions. As the suppressed feelings of aggression and hostility are released, the drinker goes into a state of artificial display of bravery. Acute alcohol intoxication is a factor in suicides and homicides.

Alcohol slows the reactions of the victim, and he may not be able to protect himself in time from an assault. He may be struck down with a minimum or no defence injuries. Alcohol causes dilatation and congestion of blood vessels, so that injuries will result in greater and prolonged bleeding. If there is chronic alcoholic liver disease which impairs the clotting of blood, the bleeding will be more extensive. If a victim is severely intoxicated, he may die from inhalation of blood or vomit while lying on his back following injuries, especially of the head or face.

S. 510, I.P.C: Misconduct in public by a drunken person is punishable with imprisonment up to 24 hours.

Alcohol and Sudden Death : (1) In some persons alcohol has an effect on the myocardium, predisposing to and producing arrhythmias. Cocaine, amphetamine and toluene also predispose to and can cause cardiac arrhythmias by a direct action on the myocardium. (2) An intoxicated person during the struggle, or more commonly immediately after it, suddenly becomes unresponsive, develops cardiopulmonary arrest and dies. No anatomical cause for the death is found at autopsy. Catecholamines are released during struggle, which in combination with alcohol may produce cardiac arrhythmias and death. (3) Occasionally the person has a physiological lesion of the conduction system of the heart predisposing to and causing arrhythmias, which can be aggravated by alcohol and release of catecholamines. Peak levels of catecholamines are reached, immediately after cessation of the struggle. (4) After a violent struggle, the victim may be restrained in such a way, that breathing is impaired, producing a relative hypoxia. In some persons, death may result, when this is combined with alcohol and the release of catecholamines. The cause of death in such cases can be certified as "cardiopulmonary arrest, contributed by alcohol during a violent struggle". (5) Intoxicated person who is severely beaten about the face may collapse and die. The autopsy is essentially negative. Death probably occurs from a combination of CNS depression due to alcohol and diffuse axonal injury from beating.

Alcohol after Death: Alcohol diffuses through the intact stomach wall after death into the surrounding blood and tissues, including the pericardial fluid and pleural fluid. As such, higher blood levels are found than what actually existed during life, if blood samples are taken from parts into which post-mortem diffusion has taken place, i.e., heart, or a large vein in the chest.

If death occurs instantaneously from trauma,

then a post-mortem alcohol estimation will give a true picture of the individual at such time. Subdural blood clot will contain the same concentration of alcohol as that in blood at the time of fatal injury. Such clots will give the exact concentration of alcohol at the time of the fatal injury, even though the victim may survive for several hours. In cases of severe internal injury, gastric contents may collect in the thoracic cavity. This may give rise to the possibility of diffusion of alcohol in the heart blood. No appreciable loss of alcohol from body or blood takes place by evaporation or any other means after death. With advanced putrefaction, the entire contents of the vascular system including alcohol is destroyed. Analysis of brain gives best results.

Endogenous production of alcohol is not seen in all decomposed bodies. Ethanol and other alcohols can be produced during putrefaction by fermentation of the carbohydrates and proteins of the body (usually 20 to 30 mg/100 ml). This may occur due to enzymes, bacteria, yeast or fungi. The commonest organism is E. coli. The longer the interval after death and the higher the temperature, the more is produced. Alcohol produced by advanced putrefaction may be as high as 0.2%. Alcohol concentrations in excess of 0.2% would indicate alcohol consumption prior to death, while levels below 0.2% may be attributed to possible production due to putrefaction. In cases of putrefaction, if alcohol is found in the blood and organs, but not in the urine, the alcohol reaction in the blood is probably false due to putrefaction.

METHYL ALCOHOL

Pure methyl alcohol (wood alcohol or methanol) is colourless, volatile liquid, with an odour similar to ethyl alcohol, and has a burning taste. Mineralised methylated spirit consists of 90% by volume of ethyl alcohol, 9.5% of wood naphtha, and 0.5% of crude pyridine. It is present in certain home-made beverages, antifreeze, paint removers, dyes, resins, adhesives and varnish.

Signs and Symptoms: Methyl alcohol produces symptoms of drunkenness in the same way as ethyl alcohol, but inebriation is not prominent, and the effects are more prolonged. Toxicity can result following its absorption through skin or respiratory tract. Symptoms may appear within an hour, or may not appear for 24 hours. They consist of nausea, vomiting and pain or severe cramps in the abdomen, headache, dizziness, neck stiffness, confusion, vertigo. There is marked muscular weakness, and depressed cardiac action and hypothermia. There may be dyspnoea and cyanosis. The odour is usually present in the breath. The effect on the central nervous system is more intense and persistent than with ethyl alcohol. There may be delirium and coma which may last for two or three days. There is a toxic effect on the liver and kidneys (acute tubular necrosis) and on highly specialised nerve elements. Urine is strongly acid and may contain acetone and a trace of albumin. Acidosis is caused by the inhibitory effect on oxidative enzyme systems produced by methanol with the resultant accumulation of lactic and other unidentified acids. Respiratory depression is also a factor. Severe non-diabetic anion metabolic acidosis in unconscious persons is suggestive of methyl alcohol poisoning. The pupils are dilated and fixed. Visual disturbances like photophobia and blurred or misty vision (snowfield vision), seeing spots, central and peripheral scotomata, decreased light perception, concentric diminution of visual fields for colour and form, followed by fairly sudden failure of vision or complete blindness occur due to optic neuritis and atrophy from the effects of formic acid on the optic nerve. Fundoscopy shows hyperaemia of optic disc followed by retinal oedema. The retinal ganglion cells and optic disc show degenerative changes. In fatal cases convulsions are usual as a terminal event, and death occurs from respiratory failure.

An increased osmolol gap accompanied by visual symptoms suggest methanol poisoning. An anion metabolic acidosis is characteristic of methanol, ethylene glycol and salicylate intoxication.

Fatal Dose : 60 to 200 ml.

Fatal Period : 24 to 36 hours; may be delayed for 2 to 4 days.

Absorption : It is rapidly absorbed through the stomach and intestines, and also through the lungs and the skin. Though its action resembles that of ethyl alcohol to a great extent, its rate of oxidation is one-fifth that of ehtanol and with repeated small doses tends to accumulate in the blood. 80 mg/100 ml. of blood is dangerous level. It does not completely disappear from the blood for 3 or 4 days. Methanol is oxidised by the liver to formaldehyde, (which is 33 times more toxic than methanol), which in turn is oxidised to formic acid, which is six times more toxic than methanol, which is responsible for the associated metabolic acidosis and the retinal

toxicity. Formate may inhibit the cytochrome oxidase chain increasing lactate production and metabolic acidosis. It is distributed in the tissues according to their water content, and a high concentration is found in vitreous body and optic nerve.

Elimination : About 80% is excreted unchnaged from lungs, and about 3 to 5 % is excreted unchanged in the urine.

Cause of Death: Death is mainly due to acidosis from production of organic acids, and CNS depression is a minor factor. Formic acid is the primary agent in causing severe metabolic acidosis and ocular toxicity.

Treatment : (1) Gastric lavage using 5%bicarbonate solution should be done, and 500 ml. of this may be left in the stomach. (2) Activated charcoal reduces the mortality significantly. It acts by reducing the absorption of alcohol from the digestive tract, and by creating a concentration gradient in favour of movement of alcohol and its metabolites back into the gut. (3) Ethanol is the antidote. It is given i.v. as a 10% solution, starting with 500 ml. as an infusion and repeated as required, until blood level falls below 25 mg%. Serum ethanol levels must be checked frequently to assure that a level of 100 to 150 mg.% is being maintained at all times. The i.v. route is preferred to avoid gastritis. Methyl alcohol is oxidised to formaldehyde by the enzyme catalase. This catalase can also oxidise ethyl alcohol to acetaldehyde. In methyl alcohol poisoning, ethyl alcohol by competition for catalase, blocks the formation of formaldehyde and allows the less toxic methyl alcohol to be excreted unmetabolised. (4) Alternatively, 60 ml of ethyl alcohol in 200 ml fruit juice can be given orally over a period of 30 minutes. For maintenance, give 15 ml of 50% ethyl alcohol every hour. (5) Haemodialysis is the treatment of choice in severe poisoning. It reduces the half-life of methanol from 40 hours to about one hour. There is no role for peritoneal dialysis or haemoperfusion. (6) 4 methyl pyrazole (4MP), or fomepizole. The usual dose is 15 mg/kg of 4 MP, followed 12 hours later by 10 mg/kg 12th hourly for 4 doses, and then increased to 15 mg/kg 12th hourly for as long as necessary. (7) Folinic or folic acid 50 to 75 mg. every four hours is useful to increase the elimination of formic acid, decreasing the metabolic acidosis, and reducing symptoms. (8) Blood sugar should be measured frequently while ethanol is being given, as it may cause hypoglycaemia, especially in children. (9) The basic treatment for alcoholic ketoacidosis is crystalloid therapy, dextrose, thiamine, and phosphate. Correct potassium and magnesium defects. (10) Soda bicarbonate i.v. to correct metabolic acidosis. (11) Place patient in a left lateral decubitus position with head down to avoid aspiration of vomit. (12) Eyes should be kept covered to protect them from light. (13) Keep the airway clear.

Post-mortem Appearances : Cyanosis is marked, and there is an absence of post-mortem clotting of the blood. The pyridine may give the skin a purple colour. The mucous membrane of the stomach and the duodenum is congested and inflamed with small haemorrhages. Small or large intestine or both are contracted resembling a thick pipe of a very narrow lumen. The lungs are congested and oedematous. The brain is oedematous and shows local haemorrhages. The mucosa of the bladder is often congested. The liver shows fatty change and sometimes early necrosis, and there is tubular degeneration of the kidneys.

ANALYSIS: Methyl alcohol and formic acid are found in all organs, blood and urine. Formaldehyde cannot be demonstrated probably because of the rapidity with which it combines with protein and its speedy oxidation to formic acid.

Anticoagulants such as EDTA, heparin, methanamine and formalin give a positive test for methanol.

The Circumstances of Poisoning : Poisoning is mostly accidental. Sometimes it is used as an intoxicating beverage, when ethyl alcohol is not available.

ETHYLENE GLYCOL

It is a clear, colourless, odourless, non-volatile liquid with a bitter-sweet taste. It is mainly used as an antifreeze agent. It is not absorbed though skin. It is metabolised to glycoaldehyde, glycolic acid and oxalic acid and inhibits oxidaive phosphorylation.

SYMPTOMS: Initial symptoms are vomiting, lethargy, ataxia, inebriation, convulsions and coma. In 12 to 24 hours tachycardia, tachyapnoea and circulatory collapse, electrolyte imbalance and metabolic acidosis occur. In one to three days, hypocalcaemia, oliguria, tubular necrosis and renal failure occur. Urine contains crystals of calcium oxalate.

FATAL DOSE: 100 to 200 ml.

FATAL PERIOD: 3 days

POSTMORTEM APPEARANCES: Cerebral oedema, chemical meningo-encephalitis, liver and kidney

damage may be seen. Oxalate crystals are seen in brain, spinal cord and kidneys.

TREATMENT: (1) Gastric lavage. (2) Activated charcoal. (3) Ethanol in same dose as for methyl alcohol. (4) 4-methyl pyrazole. (5) Haemodialysis. (6) I.v. sodium bicarbonate. (7) 10% calcium gluconate i.v.

ISOPROPANAL

It is a colourless, volatile liquid with a faint odour of acetone and is slightly bitter. It is used as a disinfectant, paint remover, antifreeze, sterilising agent industrial solvent and for massage. It is absorbed through all routes. It is rapidly metabolised and converted to acetone which is excreted in urine and breath. It is two to three times more potent than ethanol as CNS depressant. Fatal dose is about 250 ml.

SYMPTOMS: Abdominal pain, gastritis, vertigo, headache, lethargy, ataxia, haemorrhagic tracheobronchitis and apnoea.

TREATMENT: (1) Gastric lavage. (2) Activated charcoal. (3) Haemodialysis.

CHLOROFORM

It is a heavy, colourless, volatile liquid, with sweet pungent taste and a characteristic ethereal odour.

SIGNS AND SYMPTOMS: When swallowed there is burning pain in the mouth, throat and stomach and vomiting. Within ten minutes, unconsciousness and coma with slow stertorous breathing occurs. Pupils are dilated and pulse is feeble, rapid and irregular. When inhaled it causes irritation in throat and burning of eyes. The face is flushed and the patient becomes delirious. In 3 to 4 minutes, patient becomes unconscious and corneal and other reflexes are lost. Pulse and respiration are slow and feeble, temperature subnormal and pupils contracted. All the muscles are relaxed. If the inhalation is continued, the patient passes into a stage of paralysis. Skin is cyanosed and pupils dilate. Deah occurs from cardiac or respiratory failure.

FATAL DOSE: Thirty ml. when ingested; a concentration of five percent or more in air when inhaled.

TREATMENT: Stomach wash, artificial respiration, stimulants and symptomatic treatment.

POST-MORTEM APPEARANCES: They are not characteristic except the smell in serous cavities, lungs and brain. There is usually marked congestion.

THE CIRCUMSTANCES OF POISONING: Accidental death may occur during anaesthesia or when liquid chloroform is swallowed accidentally. It is occasionally used for suicide. Homicide by inhalation or by ingestion is very rare. It is extremely difficult to put a person under the influence of an anaesthetic without his consent.

ETHER

It is a colourless, volatile liquid having a peculiar penetrating odour and sweetish pungent taste.

SINGS AND SYMPTOMS: When inhaled, effects are similar to chloroform, but there is more irritation of respiratory tract and more secretion of mucus and saliva. Taken by mouth effects are similar to alcohol, but is more rapid in onset and shorter in duration.

FATAL DOSE: Thirty ml.

TREATMENT: As for chloroform.

POST-MORTEM APPERANCES: Brain is slightly oedematous. Trachea contains frothy mucus. Lungs are congested and oedematous.

OPIUM

Opium (afim) is the dried juice of the poppy (Papaver somniferum) which is cultivated in India and other Eastern countries, only under a licence. The plant grows up to one metre in height. Each plant bears 5 to 8 capsules. Flowers are white. The unripe capsule is incised and the white juice which exudes is collected and allowed to evaporate to obtain opium. Ripe and dry poppy capsules contain a trace of opium and are used for their sedative and narcotic action. Their warm decoction is used locally as a sedative fomentation and poultice. Poppy seeds (khaskhas) are white, harmless, demulcent and nutritive and are used as food. The oil from the seeds is used for cooking purposes. Opium occurs in rounded, irregularly formed or flattened masses and has a strong characteristic odour and bitter taste. When fresh, it is soft, flexible and internally moist, coarsely granular or smooth and reddish-brown on keeping. Crude opium contains a large number of alkaloids, about 25, combined with meconic, lactic and sulphuric acids. These form two chemically different groups: (a) the phenanthrenes: morphine (about 10%), codeine (about 0.5%), and thebaine (about 0.3%), which are narcotic, and (b) the isoquinoline group: papaverine (about 1%), and narcotine (about 6%), which have mild analgesic but no narcotic properties. Thebaine acts as convulsant

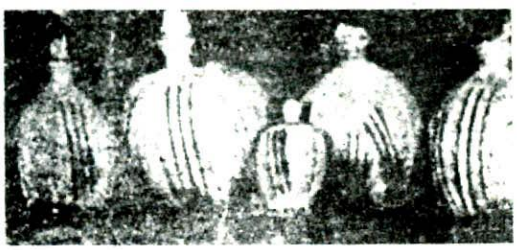


Fig. (30–1). Poppy capsules.

Morphine occurs as white powder or as white shining crystals, has bitter taste and alkaline reaction. The narcotic symptoms of opium poisoning are practically those of morphine poisoning.

Classification: (1) **Natural:** morphine, codeine. (2) **Semi-synthetic:** heroin, hydromorphone, oxymorphone, oxycodone. (3) **Synthetic:** meperidine, methadone, levarphanol tartrate, paregoric, diphenoxylate, fentanyl, propoxyphene.

Opioids are substances having action similar to opium but not derived from it.

Action: Opiates exert their effects because of their chemical similarity to natural substances called endorphins. The opiate drugs activate receptor sites normally occupied by the natural opiates or endorphins. Opium depresses all centres except oculomotor, vomiting and sweating. It is a peripherally acting analgesic. It stimulates non-propulsive rhythmic contraction of small intestine. Opium and its derivatives act synergistically with alcohol and barbiturates.

Fatal Dose: Opium 2 g; morphine 0.2 g; codeine half g. Fentanyl is 50 to 100 times more potent than morphine.

Fatal Period: 6 to 12 hours.

Signs and Symptoms: The contact of morphine with the skin of sensitive persons may cause erythema, urticaria and itching dermatitis.

When opium is taken by mouth, symptoms begin within half hour. If the drug is injected, its action is noted within 3 or 4 minutes. It first stimulates, then depresses and finally paralyses the nerve centres.

(1) Stage of Excitement: This stage is of short duration, and may be absent if a large dose is taken. There is an increased sense of well-being, increased mental activity, freedom from anxiety, talkativeness, restlessness or even hallucinations, flushing of face and greatly excited or maniacal condition may be seen.

(2) Stage of Stupor: The symptoms are headache, nausea, vomiting, incapacity for exertion, a sense of weight in the limbs, giddiness and drowsiness. The subject lies motionless, with eyes closed as if in a sound sleep from which he may be aroused at first, but soon passes into stupor and coma. The pupils are contracted, face and lips are cyanosed and an itching sensation is felt all over the skin. The pulse and respirations are normal.

(3) Stage of Coma: The patient passes into deep coma from which he cannot be roused. The muscles become flaccid and relaxed and all reflexes are abolished. The face is pale, and conjunctivae congested. The pupils are contracted to pinpoint size and do not react to light but dilate during the agonal asphyxial phase caused by respiratory depression and ultimate paralysis. All the secretions are suspended except sweat. The skin is cold and often covered with perspiration. Temperature is subnormal. Blood pressure is low, the pulse slow and full, the breathing is slow and stertorous and may be reduced to 3 to 4 per minute. The odour of opium may be present in breath.

In case of fatal termination, lividity of the surface increases, pulse becomes slow, irregular and imperceptible, the respiration becomes Cheyne-Stokes in type, and finally death occurs in deep coma from asphyxia.

The skin blistering seen in dependent parts of victims of deep coma is due to cutaneous oedema caused by cessation of venous return following muscle flaccidity.

DIFFERENTIAL DIAGNOSIS: (1) OPIUM POISONING: The odour of breath, slow pulse and moist perspiring skin are prominent. The triad of coma, pinpoint, immobile pupils and respiratory depression are diagnostic.

(2) ACUTE ALCOHOLIC POISONING: Odour of alcohol in breath, congested eyes and hyperaemia of face and neck, pupils dilated and reacting, subnormal temperature, slow and stertorous breathing.

(3) BARBITURATE POISONING: Shallow respiration, deep coma, no response to painful stimuli, deep reflexes are depressed, subnormal temperature, low blood pressure, thready pulse, dilated pupils.

(4) CARBOLIC ACID POISONING: Odour of breath, white patches on lips and mouth, and carboluria.

(5) CARBON MONOXIDE POISONING: History of exposure to poisoning with gas, intermittent convulsions, cherry-red colour of skin and carboxyhaemoglobin in blood.

(6) EPILEPTIC COMA: History of characteristic seizures, pupils fixed and dilated, skin flushed, face and lips cyanosed, froth at the mouth and nostrils, tongue may be bitten, slow respiration, rapid recovery.

(7) URAEMIC COMA: Gradual onset, pallor of face, Cheyne-Stokes respirations, ammoniacal odour, general anasarca, epileptiform convulsions, albumin, blood and casts in urine.

(8) DIABETIC COMA: Gradual onset, flushed face, slow and deep respirations, low intraocular tension, subnormal temperature, sweet odour of acetone

in the breath, sugar and acetone in the urine.

(9) HYSTERICAL COMA : Usually in females, previous history with convulsive movements, usually occurs in presence of audience, unusual attitude, reflexes are not altered.

(10) CEREBRAL HAEMORRHAGE : Old age, sudden onset, history of hypertension, slow, full pulse, Cheyne-Stokes respirations, paralysis, usually hemiplegia, dilated pupils, raised temperature, bilateral extensor plantar reflexes.

(11) BRAIN TRAUMA : History or evidence of head injury, bleeding from nose, mouth or ears, respirations rapid, irregular or Cheyne-Stokes, pulse rapid later slow, pupils inactive, often unequal, paralysis of cranial nerves, subconjunctival haemorrhages.

(12) CEREBRAL MALARIA : History of fever with rigors, enlarged spleen, may be hyperpyrexia.

(13) ENCEPHALITIS : Acute onset, fever, involuntary movements, ocular palsies, changes in cerebrospinal fluid.

(14) MENINGITIS : Gradual onset, signs of meningeal irritation, fever, CSF changes.

(15) HEAT HYPERPYREXIA : Prolonged exposure to high temperature or sun, congested conjunctivae with contracted pupils, hyperpyrexia, absence of sweating, dry skin, circulatory collapse, and convulsions.

Treatment : (1) Wash the stomach thoroughly and frequently, with a solution of 1 : 5000 potassium permanganate, leaving some of the solution in the stomach for oxidising the alkaloid. Gastric lavage should be carried out even after hypodermic injection of the drug, for the alkaloid is re-excreted into the stomach after absorption. (2) A tablespoonful suspension of charcoal may be introduced into the stomach. (3) The intestines should be cleared out by enema twice daily for two days to prevent reabsorption. 30 g. of sodium sulphate by mouth with large amounts of water is also helpful. (4) Establish adequate airway. Use endotracheal intubation, if necessary. (5) Atropine is not recommended, for it can cause death by paralysing the motor and sensory nerves just like morphine. (6) Naloxone hydrochloride is a specific opioid antagonist. Unlike levallorphan and nalorphine, it neither causes psychotomimetic effects nor CNS depression. It competes with opioids at receptor sites. It can reverse not only the respiratory depressant, analgesic and euphoric effects of opioids but also the dysphoric, delusional, and hallucinatory properties of the synthetic opioids. Two mg. is given i.v. if there is respiratory depression, and repeated every half to one min. up to a total dose of 10 to 20 mg. i.v. It can be given i.m. or sublingually. Both coma and cardiopulmonary depression are reversed. If there is no response in two minutes, endotracheal intubation is necessary, and the same dose should be repeated. In any opioid overdose, a continuous infusion at a rate of 0.4 to 0.8 mg/per hour may be continued up to 48 hours, especially those with long-acting opioids such as methadone. (7) Nalmefene has longer duration of effect than naloxone. 0.1mg is given i.v. and if withdrawal reaction does not occur 0.5 mg is given, followed by 1 mg in 2 o 5 minutes if necessary. It can be given i.m. or s.c. **(8) Coma Cocktail:** In comatose patients where the identity of poison is not known, 100 ml. 50% glucose, 100 mg. thiamine, and 2 mg. naloxone should be given i.v. (9) Nalmefene has longer duration of effect than naloxone. 0.1 mg is given i.v.; followed by one mg in 2 to 5 minutes. (10) Nalorphine and levallorphan are not recommended. (11) Dextrose 50 ml. of 50% solution i.v. and thiamine 100 mg. (12) Physostigmine 0.04 mg/kg. i.v. may be given to reverse respiratory depression. if naloxone is not available. (13) Amiphenazole 20 to 40 mg i.v. can be given if necessary. (14) If the patient is seen in the early stage, he should be made to walk about in the open air to help excretion, but if poison has been absorbed and is acting upon the cells of the cortex it may do more harm than good by further exhausting the patient. (15) When coma is deep, artificial respiration should be carried out continuously and oxygen given by inhalation. (16) Analeptics, e.g. amphetamine, caffeine, or ephedrine, may be given. (17) Symptoms are treated on general lines.

Post-mortem Appearances : They are not characteristic, but signs of asphyxia are prominent. The face and the nails are cyanosed. Froth is seen at the mouth and nostrils. Post-mortem staining is well-marked and cyanotic. The smell of opium is noticed on opening the chest, but it disappears if putrefaction has set in. The stomach may contain small lumps of opium. The trachea and bronchi are congested and covered with froth. The lungs are oedematous and congested. The brain, meninges and abdominal organs are congested. The blood is usually dark and fluid. Opium disappears rapidly from the cadaver.

Absorption : It is absorbed from mucous

membranes, raw surface or wounds, hypodermic injection and when smoked in cigarettes.

Elimination : It is destroyed by the tissues, particularly by the liver. It is eliminated mainly as morphine in urine and faeces, and also by stomach, intestines, saliva, bile and milk. Morphine can be easily recovered from blood, urine and bile.

MARQUIS'S TEST : A drop of a mixture consisting of three ml. of concentrated sulphuric acid, and three drops of formalin added to a fragment of the suspected residue produces a purple-red colour which gradually changes to violet and finally to blue.

Poisoning : (1) Opium is selected by suicides because death is painless. (2) It is rarely used for homicide because of its bitter taste, characteristic smell and colour. (3) Poisoning may occur in addicts. Drugging of children by opium to keep them quiet, and overdosage of medicines containing opium may result in accidental poisoning. (4) It is rarely used as cattle poison. (5) It is sometimes used for doping race horses. (6) Sometimes opium is used to steady the nerves for doing some bold act requiring special courage.

Chronic Poisoning: (morphinism; morphinomania): The mechanism of tolerance is not known, but is thought to reside at a cellular level. The habit is acquired by young people as it is believed to be an aphrodisiac and as it produces a sense of euphoria. Opium addicts can tolerate 3 to 6 g. per day. The morphine addict has a dry skin, and shows scars of healed abscesses or abscesses themselves, and sometimes tattooing from needles. The habitual use first causes a pleasurable feeling of relief and well-being, but as larger doses are taken there is disinterest, and recurring periods of depression follow. The patient becomes restless and irritable and sleep is disturbed by dreams or there is insomnia. Loss of memory, mental fatigue and gradual intellectual and moral deterioration occur. Hallucinations may occur. Constipation, contracted pupils, anorexia, emaciation and weakness and impotence are frequent. Sudden cessation of opioid use in dependent pregnant woman may be life-threatening to the foetus.

Treatment: (1) Gradual withdrawal of drug. (2) Methadone 30 to 40 mg. daily to be tapered off gradually. (3) Dihydrocodeine or codeine may be suitable for the less severely opiate dependent, not conrolled with symptomatic treatment. (4) Propranolol 80 mg. relieves anxiety and craving. (5) Tranquilisers or sedation at bed time. (6) Psychiatric counselling.

Morphine can sometimes be detected in liver or bile even when none is detectable in blood or urine. Opiate drugs can be identified in the hair.

HEROIN (Brown Sugar): There are three types of heroin, white, brown and black tar. Street heroin is known as "smack, junk, or dope" and is diluted with quinine, lactose, mannitol, etc. A combination of heroin and cocaine is known as "speedballs". It is the most dangerous among all drugs of addiction. It can be smoked or injected, or used as snuff. Fatal dose is abot 50 mg.

It is metabolised to monoacetylmorphine or acetylmorphine. Monoacetylmorphine is then hydrolysed to morphine (half life 38 minutes). As such, chemical analysis will detect morphine but not heroin. After injection, morphine and monoacetylmorphine are found in the urine almost immediately. Tolerance occurs very rapidly (within days) and can be increased to more than hundred times the initial dose. Intense euphoria lasts for several minutes followed by sedation for about one hour, and the effects are completely lost in 3 o 6 hours. It causes excitation by lifting cortical inhibitions similar to alcohol. It can cause sudden death, even in persons who have been using it for some time, with the needle still in the vein. A few deaths may be due to some personal hypersensitivity to the drug. Fatal dose is 50 mg. Overdose causes death from a very strong CNS depressant action. In almost all cases, the victims are under the influence of alcohol at the time of death.

Treatment : (1) Methadone 40 mg. daily will usually prevent withdrawal symptoms; in a chronic addict. 80 mg. will usually prevent heroin-induced euphoria. The dose is gradually reduced by 20% daily. If signs of withdrawal appear, dose reduction should proceed more slowly. Heroin addicts should never be given 20 mg. methadone at one time. (2) Detoxification. (3) Narcotic antagonist, such as naltrexone, naloxone, haloperidol, clonidine and cyclazocine.

Autopsy: Lungs are heavy and congested, Severe pulmonary oedema is the common autopsy finding probably due to sudden ventricular dysrhythmia. Microscopically, lungs show foreign body granulomas. Liver shows chronic triaditis with mononuclear cell infiltrates.

MEPERIDINE (pethidine): Meperidine hydrochloride is a colourless, crystalline powder with a bitter taste. It is administered by the i.m. or i.v. route for its analgesic, antispasmodic and sedative properties.

Action: It acts on the cerebrum and produces analgesia and sedation.

Fatal dose : about 2 gm.

Fatal period : 24 hours.

Symptoms: Effects are similar to those of morphine. It causes more dizziness than morphine and greater elation. Tolerance to its toxic effects is not complete, and addicts may have twitchings, tremors, mental confusion, hallucinations, dilation of the pupils, dry mouth and sometimes convulsions. The impairment of ability to work is more than with morphine. Abstinence syndrome resembles that of morphine withdrawal and symptoms appear in 3 to 4 hours, and reach maximum intensity 8 to 12 hours later. Then they decline rapidly and disappear in four to five days.

It is a drug of addiction. The addiction is common among doctors and nurses. Monoamine oxidase inhibitors and phenothiazines can produce severe reactions and even death when taken together with pethidine.

Treatment: Same as for opium.

Other opioid drugs of addiction include: codeine, dihydrocodeine, papaverine, pethidine, methadone, dipipanone, dextromoramide, pentazocin, cylizine, diphenoxylate and dextropropoxyphene.

BARBITURATES

They are white, crysalline, odourless powders, with a faintly bitter taste.

Pharmacological Action : They have a depressant action on the central nervous system. Large doses directly depress the medullary respiratory centre.

Classification : (1) Long-acting : (onset of action 2 hours and duration of action 6 to 12 hours): Barbitone, phenobarbitone, methyl phenobarbitone, diallylbarbituric acid, mephobarbital, phenytoin.

(2) Intermediate-acting : (onset of action half to one hour and duration of action 3 to 6 hours): Amobarbitone, butobarbitone, probarbitone, sodium amytal, aprobarbital, vinbarbital, allobarbitone.

(3) Short-acting : (duration of action less than 3 hours) : Cyclobarbital, pentobarbital, seconal, ortal, amobarbital, cyclobarbitone, quinalbarbitone.

(4) Ultra-short acting: (onset of action immediate and duration of action about 5 to 10 minutes). Pentothal sodium, kemithal sodium, thiamylal sodium.

Absorption, Distribution and Elimination: They are rapidly absorbed from the gastrointestinal tract including the rectum, and from the subcutaneous tissues. They are concentrated in the liver for a short time, and then evenly distributed in the body fluids. They are partly destroyed in liver and excreted in urine. Barbiturates, alcohol and CO produce irreversible brain damage and yet the patient survives for a sufficiently long period so that they are completely metabolised or excreted before death occurs.

Action: CNS depression.

Signs and Symptoms : Acute poisoning may result from a single large dose or with repeated small doses. Usually the first symptom is drowsiness. A short period of confusion, excitement, delirium, and hallucinations is common. Ataxia, vertigo, slurred speech, headache, paraesthesias, subjective visual disturbances occur. A stupor progressing to deep coma, with inhibition or loss of superficial and deep reflexes, and gradual loss of response to painful stimuli occur. The Babinski toe sign may become positive. Respirations may be rapid and shallow or slow and laboured, but the minute volume is always reduced. There is a fall in cardiac output and an increase in capillary permeability leading to an increase in the extracellular fluid. Mild but progressive cardiovascular collapse, evidenced by cyanosis, hypotension, weak rapid pulse, and cold clammy skin occurs. The pupils are usually slightly contracted but react to light; they may dilate during terminal asphyxia. Decreased peristalsis may occur in deeply comatose patient and tends to be a bad prognostic sign. The urine may be scanty or suppressed and may contain sugar, albumen and haematoporphyrin. Incontinence of urine and faeces may occur. The body temperature is usually reduced; fever indicates bronchopneumonia. Respirations become irregular, sometimes Cheyne-Stokes in character and finally stop. There is delirium, hallucinations, ataxia, paraesthesias, loss of reflexes, hypotension, cyanosis, stupor progressing to coma. Blisters ("barbiturate blisters") on the skin, often on an area of erythema, strongly suggest barbiturate poisoning. Blisters contain clear serous fluid. Rupture of a blister leaves a red, raw surface which later dries to a brown parchment-like area.

They are commonly found in sites where pressure has been exerted between two skin surfaces, such as the interdigital clefts and inner aspects of the knees, buttocks, backs of thighs, calves and forearms. Occasionally, an entire side of a forearm or a thigh is blistered. Blisters occur in about 6% of cases, and are believed to be due to a direct toxic action on the epidermis. The coma may continue for a few hours to a few days and the patient then makes a gradual recovery. During recovery nystagmus, diplopia and temporary failure of accommodation may occur. Death may occur from respiratory failure or ventricular fibrillation in early stages, and bronchopneumonia or irreversible anoxia with pulmonary oedema in the later stages. The combination of alcohol and barbiturates causes rapid death.

Patients who have taken an overdose of phenobarbitone may remain unconscious for a prolonged period of time, but they tend to remain at a somewhat safer level of unconsciousness than patients who have taken a large overdosage of shortacting barbiturate. Severe shock of respiratory failure are more common and more serious with medium and short-acting barbiturates.

Fatal Dose:

Short-acting : One to two g.

Medium-acting: Two to 3 g.

Long-acting : Three to 5 g.

The **lethal blood levels are:**

Long-acting : Ten mg. per 100 ml.

Medium-acting : Seven mg. per 100 ml.

Short-acting: Three mg. per 100 ml.

Fatal Period: One to two days.

Treatment: (1) Gastric lavage should be carried out (up to 8 to 24 hours post-ingestion), with warm water mixed with potassium permanganate and suspension of activated charcoal or tannic acid. A concentrated solution of magnesium sulphate should be left in the stomach to produce purgation and minimise intestinal absorption. (2) There is no specific antidote. Analeptics do not shorten the period of unconsciousness or increase the rate of excretion. Analeptic therapy should be avoided unless a clear and compelling need exists. (3) **'Scandinavian Method'**, uses anti-shock measures, maintenance of patent airway, and adequate respiratory support. CNS stimulants have been totally eliminated. Fluid replacement therapy should be used and not vasopressors. If shock persists dopamine should be given. (4) Normal saline with five percent glucose i.v. increases the rate of excretion. Two-and-half to three litres should be given in 24 hours. (5) Artificial respiration and oxygen is given. (6) The patient should be kept warm and mucus removed from the throat, either by raising the foot of the bed or by aspiration. An endotracheal tube may be left *in situ* for the first 3 days, but after this a tracheastomy should be done. (7) Bowels should be evacuated by enema. (8) Noradrenaline two mg. diluted with 500 ml of 5% glucose in saline i.v. to counteract shock and low blood pressure. (9) Haemodialysis and exchange transfusion are sometimes life-saving. (10) Charcoal haemoperfusion. (11) Forced alkaline diuresis is most useful in poisoning by barbiturates which are not protein-bound like phenobarbitone, allobarbitone and barbitone. Increasing urinary pH interferes with the renal tubular reabsorption of phenobarbitone by increasing the ionic form of the drug in the urine. It is not of much use in cases of poisoning by barbiturates which are more protein-bound, have a large volume of distribution and are less poisonous. Forced diuresis is brought about by mannitol 100 to 200 ml. of 25% solution, followed by an infusion of 500 ml. of 5% solution during the next 3 hours. It can be continued alternating with 5% dextrose solution for the next 24 hours so as to maintain a urine volume of 10 to 20 litres in 24 hours. (12) For deep-vein thrombosis and thromboembolism in patients with prolonged coma, mini–heparinisation, elastic stockings, and inflable cuffs are useful. (13) Antibiotics to minimise risk of pneumonia. (14) Symptomatic treatment.

Post-mortem Appearances : They are not characteristic, but are mainly those of asphyxia. Cyanosis is present. A quantity of white particles of ingested barbiturate may be seen in the stomach. The gastric mucosa may be eroded. The fundus may be thickened, granular and haemorrhagic. The cardiac end and lower oesophagus may be eroded from regurgitation. Haemorrhagic blistering and haemorrhagic necrosis of the gastric mucosa may be seen due to poisoning from seconal and sodium amytal. The lungs are congested, oedematous and pneumonic. Petechial haemorrhages may be present in the lungs and on the pleura and pericardium. The lungs may be almost black. the whole venous system is engorged with dark, deoxygenated blood. The kidneys show degeneration of the convoluted

tubules. Other organs are congested. In delayed deaths, there is symmetrical necrosis of the globus pallidus and corpus callosum, focal areas of necrosis in the cerebrum and cerebellum and a variety of vascular lesions. Putrefaction causes significant decrease in blood barbiturate levels.

DETECTION : Calorimetric methods have now been superseded by specific gas-liquid and high pressure liquid chromatography methods.

Chronic Poisoning : It occurs when barbiturates are used therapeutically in epilepsy or psychoneurotic patients. The signs and symptoms resemble those of chronic alcoholism with progressive impairment of cerebral function, dysarthria, ataxia and depression. Tendon reflexes may be depressed, or there may be hypertonia and tremors of Parkinsonian type. Addiction is a serious problem. Dependence is both psychic and physical. The impairment of mood, behaviour, and intellectual functions causes social deterioration. Withdrawal symptoms appear within a day and may persist for two weeks. Common features are anxiety, nausea, vomiting, weakness, hypotension, tremors and disturbances of vision. Convulsions may occur.

The Circumstances of Poisoning : Barbiturates are commonly used for committing suicide. Due to the large size of a fatal dose and prolonged unconsciousness, they are rarely used for homicide. Accidental poisoning may result due to "automatism" (involuntary suicide).

METHAQUOLONE: "Mandrax" and "melsedine" containing methaquolone are used for insomnia. Some persons are extremely sensitive to this drug and may become unconscious even after one tablet. If it is taken some hours after food, the patient may feel dizzy, sweat and a syndrome similar to hypoglycaemia is produced. Two-and-half g. of the drug produces unconsciousness within half hour.

Symptoms: In modest doses, the drug produces an euphoric state, and inhibitions disappear. Excitation, delirium, extrapyramidal signs (hypertonicity, hyperreflexia and myoclonus) and convulsions occur. Muscular twitchings, extensor plantar response, carpopedal spasm and paraesthesia, tachycardia, cardiac arrhythmias ranging from patterns similar to pericarditis, incomplete to complete bundle branch-block, or myocardial infarction, hypotension, hypothermia, hypoprothrombinaemia and gastric bleeding.

Addiction may occur, and some degree of tolerance is seen after prolonged use. Excretion is mainly in the urine.

Treatment: Stomach wash and symptomatic.

CHLORAL HYDRATE: It is colourless, crystalline substance having peculiar pungent odour, and a pungent bitter taste. Its principal action is to depress the central nervous system.

Absorption : It is absorbed rapidly form the stomach and small intestine, and also from the rectum. It is metabolised rapidly in the liver, mainly to trichloroethanol which is also hypnotic. Trichloroethanol is conjugated with glucuronic acid and excreted in the urine.

Signs and Symptoms : They resemble those of barbiturates, but in addition there is retrosternal burning sensation, vomiting, and rarely jaundice. Albuminuria may be found due to renal damage. Sometimes, due to idiosyncrasy, a scarlatinal or urticarial rash may be seen on the skin. Hepato-renal damage may occur. Death usually occurs from paralysis of the respiratory centre. In a few cases, death may occur from failure of the heart soon after swallowing the drug.

Chronic poisoning: It occurs after prolonged therapeutic use. Symptoms are those of gastro-intestinal irritation with erythematous and urticarial eruptions on skin, tremors and dyspnoea. Convulsions, mental degeneration and liver damage may occur. Habitual use can lead to tolerance and physical dependence with delirium when the drug is withdrawn.

Fatal Dose: 5 to 10 g.

Fatal Period : 8 to 12 hours.

Treatment : (1) Wash the stomach with alkaline solution. (2) Forced diuresis or dialysis. (3) Flumazenil 0.1mg. as infusion to a total of 3mg. produces marked improvement. (4) Symptomatic.

Post-mortem Appearances : Gastric mucosa is softened and reddened and eroded, and smells of chloral hydrate. Brain and lungs are congested. Hepato-renal damage is seen.

The Circumstances of Poisoning : Accidental poisoning results by taking large doses as hypnotic. Suicidal cases are rare. It is given in food or drink to render a person suddenly helpless for the purpose of robbery or rape. Its action is so rapid under such conditions that it has been given the name of **'knockout drops'.** A combination of alcohol and chloral is commonly known as **'Mickey Finn'.** It is often added to liquor to increase its potency.

BROMIDES: Potassium and sodium bromide are in constant use in medicine. Acute fatal poisoning is rare and is likely to occur only in circumstances of suicide. Poisoning is usually accidental. Up to ten percent patients exhibit intolerance.

SIGNS AND SYMPTOMS: There may be nausea, colic and vomiting due to the local action, followed by vertigo, staggering gait, mental confusion, fall of blood pressure, feeble pulse, subnormal temperature, shallow respirations, muscular weakness or paralysis, collapse, stupor or coma. It usually appears within a few days of the commencement of taking the drug though rarely after a long period of tolerance. There may be irritation and oedema of the mucous membranes. The bromides displace chlorides from plasma and cells, and may cause fatal depression of the nervous system. Excessive consumption may lead to clinical picture resembling intoxication.

FATAL DOSE: 30 to 45 g. 50mg/100ml. blood is a toxic level.

FATAL PERIOD: 6 to 18 hours or more.

TREATMENT: (1) Gastric lavage. (2) Chloride increases the elimination of bromides, and as such, normal saline i.v. by drip method, or 2 g. of sodium chloride in capsules every four hours by mouth are useful. (3) Haemodialysis in severe poisoning. (4) Symptomatic treatment.

POST-MORTEN APPEARANCES are not characteristic.

TEST: They give a whitish-yellow precipitate with silver nitrate, which is not readily soluble in ammonium hydrate, but is soluble in potassium cyanide.

CHRONIC POISONING (BROMISM): It results from the continued ingestion of bromides. There is blunting of memory, muscular weakness and incoordination, skin rashes, and there may be delusions and hallucinations.

In over 30% of cases of chronic bromide ingestion, a "bromide rash" develops. It begins as an acneiform eruption on the face and may spread to the whole body.

PARALDEHYDE

This is a clear, colourless liquid with an unpleasant ethereal odour, and an acrid nauseous taste. It is used as a hypnotic by mouth, rectum or parenterally and as a basal anaesthetic. Fatal poisoning is uncommon. Poisoning is usually accidental. Suicide is rare. It is a less common drug of addiction.

SIGNS AND SYMPTOMS: When ingested there is nausea, vomiting, eructations, headache and giddiness and the breath smells of paraldehyde. Drowsiness sets in, pulse becomes slow and feeble, shallow breathing, dilated pupils, cyanosis, subnormal temperature and coma and death may occur from respiratory failure. Pulmonary oedema and bronchopneumonia are common.

FATAL DOSE: 25 to 509 ml. orally; 10-12 ml. parenterally.

FATAL PERIOD: Few hours.

TREATMENT: (1) Gastric lavage with a solution of sodium bicarbonate to be continued until washings cease to smell of the drug. (2) Activated charcoal is useful. (3) High colonic irrigation. (4) Clacium gluconate and dextrose intravenously. (5) Artificial respiration and oxygen inhalation. (6) Symptomatic.

POST-MORTEM APPEARANCES: The body smells of paraldehyde. The mucosa of the stomach is hyperaemic and may be slightly inflamed. The viscera are congested. Pulmonary oedema and brochopneumonia are usually seen.

CHRONIC POISONING: Symptoms are similar to those seen in chronic alcoholism, such as gastric irritation, muscular weakness, and tremors of the hands and tongue. Hallucinations and delusions may be present.

HYDROCARBONS

Most of the hydrocarbons are derivatives of petroleum distillates. Aliphatic hydrocarbons include gasoline, naphtha, mineral spirits, kerosene, butane, propane, turpentine, paraffin wax, petroleum jelly, tars, asphalt and mineral seal oil. Halogenated (chlorinated) hydrocarbons include organochlorines, methyl bromide, fluorocarbons, methylene chloride, carbon tetrachloride, trichloroethylene and tetrachloro ethylene. Aromatic hydrocarbons are benzene, toluene, xylene and naphthalene. Turpentine and pine oil are poducts of wood distillation. The toxic substances like gasoline, kerosene, naphtha, mineral spirit, light gas oil, and mineral seal oil are poorly absorbed from the GI tract. Benzene, toluene and xylene are highly volatile and well absorbed from the GI tract. Methane and butane are gases and act as simple asphyxiants. LPG is a mixture of butane and propane. Lubricating oil and asphalt are non-toxic. Turpentine and pine oil are readily absorbed from the GIT.

Signs and Symptoms: (1) Acute or chronic cotact with hydrocarbons causes chronic eczematoid dermatitis, with redness, itching and inflammation. Cutaneous exposure to gasoline and other hydrocarbons can cause second degree burns, and systemic manifestations. Fever may be present. (2) **Pulmonary:** Gasping, coughing and choking indicate aspiration. Nasal flaring, intercostal retractions,

dyspnoea, tachyapnoea and varying degrees of cyanosis are seen. If severe injury occurs, pulmonary symptoms progress up to 48 hours, with complete resolution in 3 to 5 days. (3) CNS depression somnolence, dizziness, convulsions and coma. (4) Eye: Photophobia, redness and transient corneal irritation. (5) Cardiac involvement is rare after acute igestion. During solvent abuse especially with chlorinated and fluorinated hydrocarbons sudden death secondary to dysrhythmias can occur.

Methane or butane inhalation causes hypoxia. They can cause CNS symptoms but lungs are spared. Gasoline, turpentine and naphtha are aspirated and can cause CNS depression, but effects of GI absorption are not significant. Petroleum spirits, kerosene, mineral seal oil cause pulmonary complications. Lubricating oils, mineral oil, asphalt are non-toxic but may cause lipoid pneumonias in cases of direct aspiration. CNS toxicity following ingestion appears to be indirect and secondary to pulmonary involvement.

Chronic exposure: Benzene is considered a human carcinogen. Aplastic anaemia, myelocytic and monocytic leukaemia have been reported. Toluene inhalation is associated with renal tubular acidosis, and peripheral sensorimotor neuropathy.

Fatal Dose: 30 to 100 ml. of kerosene. 15 to 20 ml benzene.

Fatal Period: Within one day.

Treatment: (1) Remove contaminated clothing, and wash the affected areas of skin with soap and water. In ocular exposure, prolonged irrigation with sterile solution is to be done. (2) Gastric evacuation is indicated for (a) camphorated products, (b) halogenated products (e.g. methylene chloride, carbon tetrachloride), (c) aromatic hydrocarbons, (e.g. benzene, toluene); aniline. Ipecac induced emesis is preferred over lavage. Gastric evacuation for pure petroleum distillate or turpentine ingestion is not recommended. (3) Activated charcoal has limited value. (4) A cathartic may be given. (5) Continuous positive airway pressure (CPAP) or positive end-expiratory pressure (PEEP), or high frequency jet ventilation is beneficial in severe poisoning. (6) Absorption of ingested kerosene can be slowed by giving 250 ml of liquid paraffin orally. (7) Corticosteroids.

Post-mortem Appearances : Signs of asphyxia are present. There may be acute gastroenteritis and the odour may be present in the lungs and alimentary canal. There may be atelectasis, interstitial inflammation and necrotising bronchopneumonia. The pleural and cut surfaces are deep-red and purple, oozing a blood-stained watery and frothy fluid. Petechial haemorrhages, or larger haemorrhages into the mucous membranes and subserous tissues may be found in the trachea, gastrointestinal tract and elsewhere. Cloudy swelling, or fatty degeneration of the liver and kidney may be seen. In toluene poisoning red cells may show basophilic stippling.

The Circmstances of Poisoning : Poisoning is usually accidental, especially among children. Adults may be accidentally poisoned by drinking it by mistaking it for country liquor. Suicidal poisoning is very rare. They are not used for homicide. In the siphoning of gasoline from a tank, the mobile liquid can easily be aspirated into the lungs and cause death.

TURPENTINE: It is obtained by the distillation of the oleoresin from various species of pine tree. When fresh it is colourless. It is extensively used to dissolve varnish paint and grease stains. It is climinated from the lungs importing characteristic smell to the breath. In the urine it is excreted in combination with glycuronic acid. Some amount is excreted by the skin.

FATAL DOSE: 150 to 200 ml.

FATAL PERIOD : Few minutes to 12 hours.

SIGNS AND SUYMPTOMS: SKIN: redness itching, vesication. G.I.T.: nausea, vomiting, colic, diarrhoea. R.S.: centrla depression, pneumonia. C.N.S.: excitement, giddiness, delirium, convulsions, coma, Renal: albuminuria, haematuria, oliguria, renal failure.

TREATMENT: Gastric lavage with weak solution of sodium bicarbonate. (2) demuleents. (3) supportive therapy.

POSTMORTEM APPEARANCES: Stomach shows haemorrhagic spots and contents smell of turpentine. Lungs, brain and meninges are congested. Kidneys show degenerative changes.

POISONING: (1) Accidental. (2) Suicidal. (3) Abortificient.

PHENYTOIN (anticonvulsant) causes gingival hyperplasia in chronic therapy.

NAPHTHALENE: Moth balls contain naphthalene or paradichlorobenzene. Fatal dose is 2 to 5 gm. Symptoms are nausea, vomiting, diarrhoea, abdominal pain, fever, headache, confusion, sweating, dysuria, convulsions and coma. It can cause haemolysis in patients with glucose-6-phosphate dehydrogenase deficiency and acute renal failure. (2) Chronic exposure to naphthalene can result in aplastic anaemia, hepatic necrosis, and jaundice.