

greenish yellow pungent smelling gas. On interaction with some other fires and explosions. When exposed, it causes blurred visions, burns and high exposure may result in death. Immediate treatment involves flushing the body

Hydrogen Cyanide—This is highly toxic, inflammable gas or liquid. It causes irritation to eyes, skin and throat resulting in burning of skin, drowsiness and confusion leading to collapse. It proceeds to attack the central nervous system. The best antidote is flushing with water and exposure to clean air.

Sulphur Mustards—Blistering agents having a yellow to brown colour. These are absorbed through the eyes, skin and respiratory tracts causing injury in the process. There is no antidote and only effective damage control is swift decontamination of exposed areas.

Lewisite—This is blistering agent. It causes violent sneezing, coughing, and burning of the eyes. It can lead to subnormal temperature and low blood pressure. Heavy flushing with water and exposure to clean air are the best antidote.

Ricin—This is one of the deadliest naturally occurring bio-warfare agents known to man. It is also among the most readily available to terrorists. The source is the castor bean seed, *Ricinus Communis* which is grown legitimately all over the world to make castor oil, an industrial lubricant, a leather curing agent and a laxative. About one million tonne of castor oil is produced every year.

Ricin, the poison, can be readily extracted from the waste. It is four times more toxic than cobra venom and when injected with a dose of as little as 70 µg, can kill an average adult. It can also be deadly when eaten or inhaled (dose 3 µg/kg of body weight). Eight castor oil seeds contain enough ricin to kill an adult while one to three beans could kill a child.

Ricin works as a cytotoxin or cell poison, with a single molecule capable of killing a cell by shutting down its life-support functions. Within three hours of poisoning, the victim will experience abdominal pain, vomiting and diarrhoea, often with blood in the stools, followed by severe dehydration, reduced blood pressure and collapse of liver, kidneys and lungs. Death occurs within 3 to 5 days. There is no antidote but dehydration can be handled.

Anthrax scare overwhelmed USA in 2001 following the terrorist attack (Sept. 11, 2001) when some hand-written envelopes, filled with white anthrax powder, were discovered in the White House and some government buildings which became contaminated. A few fatal cases were reported. It was subsequently revealed that the anthrax strain was derived from a strain developed for US military research.

9.15 ENVIRONMENT AND PUBLIC HEALTH

9.15.1 Pollution and Public Health Issues

Very few people have paid any attention to the dark side of industrialization, particularly to the growing dangers it poses to the health of people. Hardly a day passes when hundreds do not succumb to the accidents or diseases caused by growing pollution of the environment in general and the increasing occupational hazards or die in major industrial disaster as in Bhopal.

Industrialization is creating a high-risk environment for all. But it is the poor labourers/workers who suffer the most. They get the dirtiest and most hazardous job and are compelled to live in the dirtiest environment in close proximity to the industries. The society benefits from the industries but at the cost of the poor workers who are most neglected.

Hazardous Products

During the last 50 years about 6 million chemicals have been synthesised at the rate of 10,000 new ones every month. Some 60,000 to 70,000 chemicals are used extensively in millions of different commercial products. The world produces chemicals faster than it can manage.

These chemicals include extremely toxic substances which can cause allergies, damage vital organs of the human body like the eye, brain, liver, kidney and reproductive organs, produces deformities in babies during pregnancies of mothers and promote cancer. In case of accidental release into the environment in large quantities, as in case of Bhopal, they can lead to mass murder. What is amazing is that we know nothing about the toxic effect of 80 per cent of the chemicals used.

Industries which produce potentially toxic and hazardous wastes are pesticides, dyes and pigments, organic chemicals, fertilizers, non-ferrous metals, steel and chlor-alkali manufacturing plants.

The major locations of such industries are Delhi, Udaipur, Kanpur, Chandipur, Bokaro, Jamshedpur, Rourkela, Kolkata, Raipur, Ahmedabad, Vadodara, Mumbai, Hyderabad, Visakhapatnam, Bangalore, Chennai and Cochin. Bhopal is not included in the list, which shows that unlisted factories can cause major disasters.

Table 9.7 Toxic chemicals—uses and hazards

| Name | Uses | Hazards |
|---------------------------------------|--|---|
| Arsenic | Pesticides/Unani medicines/Glass | Toxic/Dermatitis/Muscular paralysis/Damage to liver and kidney/Loss of hair/Gangrene/Cancer |
| Asbestos | Roofing/Insulation/Air-conditioning roofs/Plastics/Fibre/Paper | Carcinogenic to workers and family members |
| Benzene | Gasoline additive/Manufacture of many chemicals | Leukemia/Chromosome damage |
| Beryllium | Aerospace industry/Ceramic parts/Household appliances | Fatal lung disease/Heart and lung toxicity |
| Cadmium | Electroplating/Plastics/Pigments/Superphosphate fertilizers | Kidney damage/Carcinogenic |
| Chlorinated organics (DDT, BHC, etc.) | Pesticides/Fungicides | Nervous depression/carcinogenic |
| Chromates | Tanning/Paints/Pigments/Corrosion inhibitors/Fungicides | Skin ulcers/Kidney inflammation/Carcinogenic |
| Lead | Pipes/Storage batteries/Paints/Printing/plastics/Gasoline additive | Neurotoxin/Blood system and brain damage |
| Manganese | Mining/Welding/Dry cell battery/Ferromanganese material (alloy) | Nerve damage/Damage to reproductive system |
| Mercury | Chlor-alkali cells/Fungicides/Pharmaceuticals | Nerve damage/Kidney damage/Fatal effect of alkyl mercury |
| Polychlorobiphenyls (PCB) | Transformers/Insulation of electricity | Carcinogenic/Nerve, skin and liver damage |
| Sulphur dioxide | Sugar industry | Irritation to eyes and Respiratory system/damage to plants/Damage to marble structures, monuments, etc. |
| Urea | Fertilizer | Bronchial problems/Kidney damage |
| Vinyl chloride | Plastics/Organic synthesis | Toxic/Carcinogenic |

Phosphatic fertilizer factories and thermal power plants generate large quantities of conventional solid wastes which are stored near the sites. Some 5 million tonnes of byproduct phosphogypsum are generated at 12 major phosphatic fertilizer plants. Twenty per cent of this waste is used to produce ammonium sulphate, while the rest containing thousands of tonnes of heavy metals and toxic metals such as chromium, copper, lead, manganese and fluorides are dumped into low lands for landfilling or into lagoons in the form of slurry.

Thermal power plants, which produce more than 50 per cent of electricity generated in India, are other major sources of solid wastes. Flyash, the solid waste, accumulates in mountainous heaps near the power stations or carried as slurry into ponds and rivers where it creates serious water pollution problems. Flyash itself contains toxic metals such as beryllium, cadmium, zinc, arsenic, manganese, etc.

From pesticide industries, some 15 tonnes of DDT and 25 tonnes of BHC (hexachlorobenzene) are carried as wastes every year which ultimately travel in the environment, enter our food chain and finally enter our body tissues where they are retained. Indians have shown maximum DDT content (25 ppm) in body tissues in the world. For the last 40 years, DDT has been banned in the western countries but it is still being used as before in India.

Occupational Hazards

Workers in mines, factories, commercial firms, forestry and agriculture are exposed to risks, high to low, which are called the *occupational hazards*. According to the United Nations, some 2 lakh workers die each year throughout the world due to accidents and occupational diseases. Another 10 millions suffer from non-fatal injuries.

Deadly Dust

The worst occupational diseases are caused by dust. These are broadly termed lung diseases (pneumoconiosis) and their effect depends on the nature of dust, its fineness, concentration, period of exposure and the victim's health.

Silicosis

It originates from dust containing free silica or silicon dioxide. It was first reported in 1947 in India in the Kolar gold mines and then found to occur in various other mines and industries—coal, mica, silver, lead, zinc and manganese mines and pottery and ceramics, sand blasting, metal grinding, building construction, rock mining, iron and steel industry and others.

In Jharkhand's mica mines, 33 per cent workers suffer from silicosis. The slate pencil factories in MP villages employ the entire village population where people do not survive beyond 40 years. Children have to work to support their mothers and often succumb early to the diseases. According to an NGO report, the workers "sign their own death warrants for economic reasons".

Asbestosis

Asbestosis is the Greek expression for "unquenchable". Because of its versatility—it resists heat and moisture—it is largely used in home construction, insulation of buildings and ships and also in car brake linings. Besides, it finds some 3,000 different industrial applications where it has to be processed into proper size. The finest fibres, invisible to the naked eye, are the most dangerous as they find ready access to our respiratory tract, line the air tubes and accumulate in the lungs.

The silica dust (from asbestos fibres) deposits in the lungs, causes pulmonary fibrosis leading to respiratory problems and death—in severe cases, it causes cancer of the air tubes and gastrointestinal tract. In UK, people living within 1 km of an asbestos factory were reported to be suffering from cancer. What is really alarming is that cancer may strike 5 to 10 years after exposure.

Byssinosis

Some 2 million textile and cotton mill workers are victims of byssinosis. Cotton emits lot of dust in various stages of its processing. The disease strikes 10 years after exposure. It progresses step by step, starting from temporary sickness of sneezing and coughing to permanent breathlessness which shortens life span. Incidence of byssinosis from 6 to 20 per cent has been reported in cotton textile mills in Ahmedabad, Mumbai, Delhi, Kanpur, Chennai, Madurai and Nagpur.

Pneumoconiosis

It is commonly associated with mines and known as the source of "black lungs". Coalmine workers who are long exposed to coal dust lose their capacity to work hard and succumb to the disease which leads to tuberculosis and death.

Child Labourers

India has a bad image abroad for employing the largest number of child labourers (16–18 million/age group 8–14). The International Labour Organisation (ILO) reports that the labourers are underpaid (Rs 2.00–6.00 per day) for 12–16 working hours and they have to toil under inhuman conditions. The brass industries of UP, carpet industries of Kashmir and match factories of Chennai employ most of the child labourers. The "Sibkasi" match factories (in Chennai) employ some 50,000 children (8–12 years old), 80 per cent being girls, who work for 14 hours a day under inhuman conditions. Most of them are vulnerable to accidents and do not live beyond 40 years.

Epidemiology

Hippocrates' suggestion over 2000 years ago that environmental factors can influence the occurrence of disease is believed to be the origin of epidemiology. However, it was not until the middle of the 19th century that the distribution of disease in specific human population groups was measured to any great extent. The first epidemiological study was made by Snow in 1854. He identified that the risk of cholera in London was related, among other things, to the drinking water supply by a particular company in London. On the basis of epidemiological studies, Snow suggested that cholera was spread by contaminated water.

Following Snow's work, public health measures, such as improving water supply and sanitation, have made notable contributions to the health of populations. Since 1854, epidemiological studies have provided the information required to identify the measures to be taken.

Epidemiology may be defined as the study of the distribution and determinants of health-related states of events in specified populations and the application of this study to the control of health problems.

Hygiene

Hygiene is closely related to epidemiology. *It is defined as the science of health that includes all factors which contribute to healthy living. The purpose of hygiene is to allow man to live in healthy relationship with his environment.*

Personal hygiene includes all those factors which influence the health and well-being of an individual. It comprises day-to-day activities for rigorously observing the elementary rules of hygiene for keeping ourselves physically fit and mentally alert through neat and clean habits as our way of life. Our daily routine should involve maintaining regular habits, e.g., taking meals at regular hours, body care (bath, wash, care of teeth, nails etc.).

9.16 HEALTH AND DISEASE

According to World Health Organisation (WHO), health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

Diseases originate from disturbances in the delicate balance between man and his environment. These can be traced to three ecological factors viz. *Agent, Host* and *Environment*. The disease agent is identified in a laboratory. Thus, hepatitis is identified, by the presence of antibodies in a laboratory. The host i.e., the patient is available for clinical examination. The environment from which the patient comes should also be scrutinised since the prevention and control of a disease is based on the knowledge of the environment.

Depending on the sources, diseases can be classified under the categories: (i) Water-borne (ii) Air-borne, (iii) Food-borne and (iv) Vector-borne diseases. Various agents like viruses, bacteria, parasites etc. are responsible for the diseases. Some common diseases are tabulated in Table 9.8.

Table 9.8 Some common diseases

| Type | Diseases |
|-----------------------|---|
| Vector-borne diseases | Malaria, Filariasis, Encephalitis, Dengue, Kala-azar etc. |
| Water-borne diseases | Cholera, Bacillary dysentery, Amoebiasis, Diarrhoea, Viral Hepatitis, Poliomyelitis, Typhoid etc. |
| Air-borne diseases | Influenza, Measles, Chicken Pox, Asthma, Bronchitis, Pneumonia, tuberculosis etc. |
| Food-borne diseases | Cholera, Dysentery etc. |

9.16.1 Vector-borne Diseases

Typical diseases—Malaria, Filariasis, Encephalitis and Dengue will be briefly described in this section.

Malaria

Malaria, meaning *bad air*, was so named because of association with odourous air of swamps, particularly at night. Malaria originates from dirty environment (breeding ground of mosquitoes) and it has been eradicated in most of the developed countries. However, it still persists in the developing countries viz. Africa, Brazil, Colombia, Afghanistan, Sri Lanka and it has staged a comeback in India. Every year, Malaria takes toll of at least 2 million lives all over the world and affects 300–500 million people. In recent outbreak in India, it killed 2000 people in Rajasthan (1994) and 1000 persons in Assam, Tripura and Bangladesh.

Malaria is caused by various species of parasites, *Plasmodium* and transmitted by the vectors *Anopheles* mosquitoes (female). The symptoms are periodic paroxysms of fever, associated with shivering and terminating with sweating. The fever is intermittent with tertian (every third day) or quartan (every fourth day) periodicity.

The credit of the discovery that malaria is transmitted by *Anopheles* mosquitoes goes to **Ross** (Kolkata) who was awarded Nobel Prize in Medicine (1903) for his work.

The prevention of Malaria needs community effort rather than individual effort. The discovery of DDT in 1939 by Paul Muller (Switzerland) paved the way for eradication of malaria by DDT spray. By 1955, the number of malaria patients dropped by about 33% all over the world and **Muller** was awarded Nobel Prize for his contribution to malaria control.

In India, the National Malaria Control Programme was started in 1953 when the annual incidence of malaria cases was 75 million with 1 million deaths. In 1976, there were 6.4 million cases with about 60 deaths.

Control of Malaria - The control methods are: (i) destruction of mosquitoes (adult) by spraying with DDT and oil dissolved in freon in houses, schools, restaurants etc. (ii) destruction of mosquito larvae in pots, cans, open drains, water bodies such as ponds etc. by spraying with pesticides (DDT, malathion) and (iii) elimination of breeding places in stagnant water pools, drains etc. by spraying with pesticides. The latter is the permanent solution to mosquito control.

Treatment - Quinine is the effective drug for malaria. Other anti-malarial drugs are chloroquine, camoquinine, primaquinine etc.

Filaria (Filariasis) - Filaria is the name of a group of diseases caused by certain nematodes (a class of worms) belonging to the family of Filarioidea transmitted by mosquitoes *Culex*, *Fatigus* and *Mansonides*. It is prevalent in Africa, Central and South America and Asian countries including Arab and India etc. the symptoms are swelling of legs or arms, genitals etc. Though not fatal, it is responsible for considerable suffering and disability.

In India, the heavily-infected states are coastal Andhra Pradesh, Orissa, Kerala, Tamil Nadu, UP, MP, Bihar and Goa.

Treatment - A number of antimony and arsenic compounds (arsenamides) can reduce or cure the disease.

Japanese Encephalitis - Japanese Encephalitis kills about 25-50 per cent affected persons. The vectors are mosquitoes - *Culex*, which breed in paddy fields with stagnant water. The hosts are pigs, cattle etc. In India, the disease is prevalent in West Bengal, North-East states, MP, UP and Tamil Nadu. The symptoms are high fever, rigid neck, convulsion etc. with high fatality rates (58%).

The disease can be prevented by spraying the infected sites with DDT/BHC (Hexachlorobenzene) as in cases of malaria and filaria.

Dengue

This is a viral disease, transmitted by the mosquito *Aedes Aegypti* found mainly in urban and semi-urban areas. The symptoms are high fever, flushed face and severe prostration.

The disease occurs in warm climates in Gulf states, Mediterranean countries and Asian countries (China, India). The first outbreak of dengue in India occurred in Kolkata in 1963 and several epidemics have been reported in Delhi, Kanpur, Asansol, Kolkata etc. Total lack of sanitary facilities among slum dwellers and unhygienic overhead water tanks among the rich and middle class families promote dengue fever and epidemic.

Recent outbreak (2005) of dengue in Kolkata and other districts caused panic with 100 deaths and 4000 infected persons.

For prevention of dengue, the breeding places of mosquito must be destroyed as in case of malaria by spraying with DDT or dieldrin and cleaning up overhead tanks at regular intervals.

9.16.2 Water-borne Diseases

The names of common water-borne diseases are given in Table 9.2. The causative agents for water-borne diseases may be virus, bacteria, protozoa or helminths. The diseases like viral hepatitis (hepatitis A, hepatitis B), poliomyelitis and diarrhoea are caused by virus. The diseases like cholera, bacillary dysentery, typhoid and paratyphoid are caused by bacteria and the diseases like amoebiasis, giardiasis are caused by protozoa. Some common water-borne diseases are discussed in detail in the following section.

Cholera

This is a highly contagious disease (water-borne and food-borne), caused by the bacteria, *Vibrio Cholerae*. Typical symptoms are diarrhoea with rice water stool, vomiting, rapid dehydration, muscular cramps and anuria. In severe case, acute renal failure is possible. Epidemics of cholera occurred in the past in India during Kumbha mela or Ardha Kumbha melas. Outbreaks of cholera were also reported in the past from Maharashtra, Tamil Nadu, Andhra Pradesh, Karnataka, Bihar, Orissa and West Bengal.

The bacteriology of cholera is complicated. *Vibrio Eltor* replaced the classical *V. Cholerae* by the end of 1965. Most of the *Eltor Vibrios* isolated were found to belong to the serotype Ogawa. *V. Cholerae* is a gram-negative, comma-shaped actively motile organism. The *Eltor Vibrios* resemble the true cholera vibrios morphologically, serologically and also biochemically.

9.16.3 Factors for Spread of Cholera

Environmental Factors

Among environmental factors, water, food, and flies play important role in spreading cholera in the community. Cholera vibrios do not multiply in water but they may survive up to two depending on temperature, pH, salt content, organic matter, sunlight and other factors. In our country, there are a large number of uncontrolled water supplies (e.g., polluted river, ponds, canals, etc.) which are major sources of cholera infection. Cholera vibrios can multiply readily in certain foods and drinks like milk, milk products and some varieties of boiled rice. Fruits and vegetables get contaminated when washed or sprinkled with water from infected areas.

Social Factors

Big fairs like Kumbha Mela or Ardha Kumbha Mela where lakhs of people assemble at the river ghats in UP are the most important factor for the spread of cholera. The crowd bathe and drink the same river water (Ganga) and rapidly spread the disease. Cholera is a disease of the poor people who come from low income groups, live in slums under unhygienic and inhuman conditions. They participate in these meals, contaminate the river water and consumed the same.

9.16.4 Control of Cholera

The control of cholera can be achieved by early detection of the disease, isolation of the patients and their prompt treatment, improvement of sanitary facilities along with adequate supply of safe drinking water to the community. Active immunisation and health awareness are also important measures for cholera control.

For early detection, bacteriological examination of stools is required for confirmation of the disease. The disease should at once be notified to the local authority who will send the information to the State Health Authority and finally to the Central Health Authority.

The treatment of cholera consists of rehydration and antibiotics. Rehydration saves life. In case of kidney failure, dialysis is required. The rehydration should be accomplished either by injecting intravenous solutions of saline (consisting of sodium chloride: sodium bicarbonate: potassium chloride = 5:4:1) or by giving oral fluid containing a mixture of sodium chloride, sodium bicarbonate, potassium chloride and glucose in the ratios of 3.5:2.5:1.5:20. gm dissolved in 11 water. Tetracycline and cotrimoxazole should be administered as antibiotic.

Improvement of sanitation for the entire community and their residential area is the most effective approach for the prevention and control of cholera. Provision for sanitary latrine for every household is essential for checking the incidence of cholera. Water to be used for domestic purposes, viz. drinking, washing, cooking, cleaning utensils, etc. from sources such as rivers, ponds, lakes, canals, etc. should be boiled. The provision of safe drinking water for all is the permanent solution as it will minimise the incidence of cholera. It is also necessary to observe the rules of hygiene rigorously—household pests—flies, cockroaches, etc. should be eliminated; cut fruits and vegetable which are exposed to dust and flies in open markets should be avoided.

Amoebiasis

This is a water-borne disease, defined by WHO as the condition of harbouring *Entamoeba histolytica* with or without clinical manifestations. It has world-wide distribution. The disease is characterised by liquid stools with mucous and blood.

E. histolytica are found as cysts or motile trophozoites. They can live outside the human body as cysts. Trophozoites cause ulcer in the large intestine. Some amoebas reach liver through portal vein, may cause hepatitis or abscess. Intestinal and hepatic amoebiasis are the main manifestations of the disease.

The cysts can live for several weeks outside the human body, if kept moist and cool. In a refrigerator they can live in water for 6–7 weeks. They do not survive at moderate temperature, e.g., 50°C.

Man gets the infection through food chain (cut fruits, salads, vegetables, contaminated drinking water, cold drink, etc.). Uncooked food and vegetable can be disinfected by washing with iodine solution (200 ppm) or acetic acid (5–10 per cent) or vinegar. From water, cysts can be removed by filtration and boiling. The cysts can be killed in milk by pasteurisation. The diagnosis is usually based on the detection of *Entamoeba histolytica* in the stools.

The antibody of the parasite can be easily detected by Immuno-fluorescence method.

9.16.5 Prevention of Amoebiasis

The disease can be prevented by (i) sanitary disposal of human excreta; (ii) provision of safe drinking water to all (water should be boiled and filtered before drinking); (iii) hygienic kitchen

practice (uncooked fruits and vegetables must be thoroughly washed or disinfected as described before); (iv) protection of foods against flies.

Treatment

The drugs usually prescribed by physicians are:

1. Metronidazole (400–800 mg) (Flagyl) to be taken one tablet thrice a day for 5–7 days.
2. Entrozyme (250 mg) - one tablet thrice a day for 7 days.
3. Trinidazole (1–2 gm)- one tablet for 3 days.
4. Furamide (500 mg)- one tablet thrice a day for 10 days.