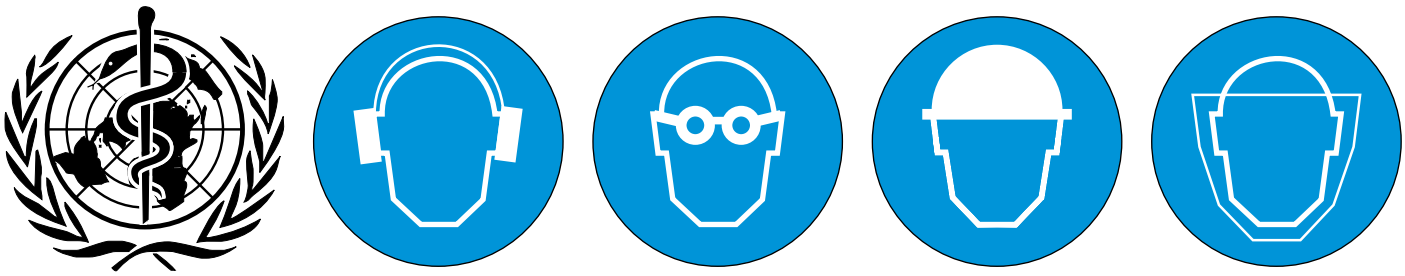
WHO-EM/OCH/85/E/L
Distribution: Limited

Occupational health

A manual for primary health care workers



World Health Organization
Regional Office for the Eastern Mediterranean

WHO-EM/OCH/85/E/L
Distribution: Limited

Occupational health

A manual for primary health care workers

World Health Organization
Regional Office for the Eastern Mediterranean
Cairo
2001

Design by John Shimwell, EDR/EMRO

Document WHO-EM/OCH/085/E/L/04.01/2000

Contents

FOREWORD

A healthy workforce is vital for sustainable social and economic development on a global, national, and local level.

The classic approach to ensuring health and safety in the workplace has depended mainly on the enactment of legislation and inspection of workplaces to ensure compliance with health and safety standards. While this approach has been effective in controlling many specific occupational hazards since the Industrial Revolution, it has not been very effective in the past several decades, particularly in developing countries, for several reasons.

First, the development of private enterprise, resulting in a proliferation of small and medium-sized workplaces, has meant that in many instances production occurs in the workers' own homes where there can be serious health hazards, including harmful dust, chemicals, noise and heat. Inspection of such workplaces is largely impossible in view of the large numbers and wide distribution.

Second, with the introduction of new agricultural techniques, agriculture has become an industry for which systems based on inspection are inadequate. There is a need to develop other systems to protect the health of agricultural workers.

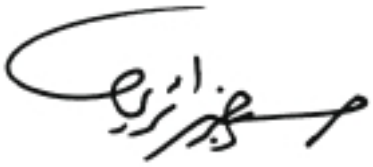
Third, occupational health problems have gradually increased in type and magnitude and have led to or aggravated diseases resulting from exposure to several risk factors, only one of which being the work environment. Examples include chronic obstructive pulmonary disease which is mainly caused by smoking but may be aggravated by irritant gases or dusts in the workplace. Low-back pain syndrome has several risk factors including rheumatic disorders, scoliosis and inappropriate posture at work.

The Declaration of Alma-Ata in 1978 led to the recognition of the importance of primary health care (PHC) workers and community health workers in bringing health care to where people live and work. PHC and community health care workers in most developing countries are not trained in the special needs of workers nor in the simple measures that can be taken to prevent or overcome and control many workers' health problems.

World Health Assembly resolution WHA 40.28 (1987) requested the Director-General of the World Health Organization "to develop guidelines on training of PHC workers in occupational health". The Regional Committee for the Eastern Mediterranean at its 38th session in 1991 passed resolution EM/RC.38/R.8 urging Member States in the Region to "include in primary health care services elements of occupational health". In response, the Regional Office, through a Regional Consultation (Amman, Jordan, 26–29 May, 1997) called for the development of a training manual which would enable PHC workers and community health workers to recognize the most common hazards in the workplace, know how to prevent and control them and use the support system available to them for referral and consultation.

Highly qualified experts in the field of occupational health have contributed to the development of this manual, which we hope will meet the needs of Member States

in their efforts to include occupational health in the PHC services. I hope this simple, task-oriented publication will be useful not only for PHC workers and their trainers at all levels but also for all specialists and interested authorities.



Hussein A. Gezairy MD, FRCS
WHO Regional Director for the Eastern Mediterranean

PREFACE

WHO policy has, since its foundation, always included elements of occupational health issues. Numerous key WHO documents and bodies, e.g. the WHO Constitution, the Declaration of Alma Ata, the Health for All Strategy, the General Programmes of Work and several resolutions of the World Health Assembly, WHO's Global Healthy Work Approach (HWA), the meetings of the network of WHO Collaborating Centres in Occupational Health, the Executive Board, the Regional Committee for the Eastern Mediterranean Region and other Regional Committees, have all emphasized the need to protect and promote health and safety at work through the prevention and control of hazards in the work environment and through the promotion of health and the work capacity of working people.

The WHO Global Strategy for Occupational Health for All, developed through the global network of the WHO Collaborating Centres in Occupational Health provides an important mechanism for protecting and promoting health at work.

According to the Declaration of Alma-Ata, 1978: "Primary health care ... is the first level of contact of individuals, the family and community with the national health system bringing health care as close as possible to where workers live and work, and constitutes the first element of a continuing health care process."

Workers are therefore an integral part in the body of the Declaration. In addition, the World Health Assembly has repeatedly requested Member States to give workers' health a high priority in the overall programme of work and to incorporate it as an essential component of PHC.

There are different levels of PHC workers: doctors in charge of occupational health, dedicated health care personnel with backgrounds in general education, health assistants, such as nurses and health technicians especially trained in occupational health, and qualified workers with vocational training backgrounds.

There are many strategies in common between PHC and occupational health. In fact, an adequate in-plant occupational health service meets almost all the principles of PHC as follows.

Health education and community participation

These are fundamental aspects of PHC and equally basic in occupational health, i.e. to educate workers in safety and health, self-care and healthy lifestyle for prevention of disease and promotion of health and to promote workers' participation in preventive programmes in the workplace which is a counterpart of "community participation".

Prevention of health hazards at the source

A primary principle in PHC and occupational health. In occupational health, identification of safety and health hazards is fundamental. Risk evaluation against hygienic standards is a known practice and control at the source is the primary objective.

Team work

A requirement in the PHC approach which becomes more specific in occupational health practice where the environmental hygienist in the workplace, the occupational physicians, nurses, safety supervisors, the employers and workers' representatives comprise the occupational health team. It is even legalized in most countries through "occupational health and safety committees" which usually comprise this team.

National occupational health programmes require cooperation and team work among the national health services: ministries of health, education, environment, industry, labour, social security and often the ministry of agriculture.

Equity

Occupational health care does not discriminate among working people. It calls for equal health care for the underserved and tries to remove any discrimination between white collar and other workers as well as between women and men.

Accessibility

There is nothing more accessible in the health care system than the in-plant health service. Efforts to make occupational health care accessible to remote areas as well as to underserved working people are what is now required.

Affordability

Occupational health is affordable. The establishment of an occupational health service should start in the early stages of developing factories and industrial plants. It is possible to use simple technology, e.g. direct reading equipment, such as a noise meter, and to follow a basic preventive programme. With early detection most diseases are preventable resulting in the minimizing of the costs of therapy. However, there are some occupational diseases which are not amenable to treatment, e.g. silicosis.

Contribution to the national economy

There is no health programme that contributes more to the national economy than that aiming at a healthy working productive population. Preventive occupational health maintains workers' productivity. Healthy workers increase industrial output and lower the cost of production and, through their incomes, they can contribute to the health of their families and their communities. Workers constitute a large sector of the population. It is not possible for a nation to survive when its labour force is weak and ill.

The goals of this manual are:

- to create a category of health personnel that is well oriented in occupational health practice in order to fill the gap in occupational health personnel and coverage for working people; and

- by following the PHC approach, to emphasize the preventive objective of occupational health services in the workplace.

The manual outlines a curriculum for training of PHC workers/community health workers. The training programme can be adjusted as required depending on the level of trainees; for example, it can be upgraded for general practitioners or simplified for workers in the workplace.

Acknowledgements

The Regional Office for the Eastern Mediterranean thanks WHO headquarters for the financial contribution which enabled the publication of this manual and gratefully acknowledges the professional contributions and advice given by the following individuals:

Dr IN Ababneh, Occupational Health Programme Manager, Ministry of Health, Amman, Jordan.

Dr S Arnaout, Regional Adviser, Health of Special Groups, WHO Regional Office for the Eastern Mediterranean.

Dr H Bashor, Associate Professor of Epidemiology, Department of Community Medicine, Faculty of Medicine, Damascus University, Syrian Arab Republic.

Dr G Eijkemans, Occupational and Environmental Health Department, Protection of the Human Environment, WHO headquarters, Geneva.

Dr MA El Batawi, former Chief of Occupational Health, WHO headquarters, Geneva.

Dr GH El Samra, Professor, Department of Industrial Medicine and Occupational Diseases, Faculty of Medicine, University of Cairo, Egypt.

Dr AM Emara, Professor of Occupational Medicine, Faculty of Medicine, University of Cairo, Egypt.

Dr ZI Fakhri, Occupational Health Department, Ministry of Health, Riyadh, Saudi Arabia.

Dr AA Farshad, Ministry of Health and Medical Education, Teheran, Islamic Republic of Iran.

Dr H Frumkin, Associate Professor of Environmental and Occupational Health, Rollins School of Public Health, Emory University, Georgia, USA.

Dr G Hafez, Special Adviser to the Regional Director, former Director, Health Protection and Promotion, WHO Regional Office for the Eastern Mediterranean, Cairo, Egypt.

Dr R Helmer, Director, Protection of the Human Environment (PHE), WHO headquarters, Geneva.

Dr MA Khalil, former Director, Health Protection and Promotion, WHO Regional Office for the Eastern Mediterranean, Cairo, Egypt.

Dr R Mahaini, Regional Coordinator, Family and Community Health, WHO Regional Office for the Eastern Mediterranean, Cairo, Egypt.

Dr MI Mikheev, former Chief of Occupational Health, WHO headquarters, Geneva.

Dr MH Noweir, Professor, Industrial Engineering Department, King Abdel Aziz University, Jeddah, Saudi Arabia.

Dr P Rookmaaker, Professor, International Ergonomics Association, The Netherlands.

Mr AS Kaleem, Specialist in Working Conditions and Environment, International Labour Organisation, North Africa Multidisciplinary Advisory Team (ILO/NAMAT), Cairo, Egypt.

INTRODUCTION

Occupational health: a definition

Occupational health is a multidisciplinary activity aimed at:

- the protection and promotion of the health of workers by preventing and controlling occupational diseases and accidents and by eliminating occupational factors and conditions hazardous to health and safety at work;
- the development and promotion of healthy and safe work, work environments and work organizations;
- the enhancement of the physical, mental and social well-being of workers and support for the development and maintenance of their working capacity, as well as professional and social development at work;
- enabling workers to conduct socially and economically productive lives and to contribute positively to sustainable development.

Occupational health has gradually developed from a mono-disciplinary, risk-oriented activity to a multi-disciplinary and comprehensive approach that considers an individual's physical, mental and social well-being, general health and personal development.

Interaction between work and health

The social and economic importance of work receives considerable attention because a primary function of work in any society is to produce and distribute goods and services. Far less attention is paid to the importance of work to the individual, yet it is clear from recent research that work plays a crucial and perhaps unparalleled psychological role in the formation of self-esteem and a sense of order. Work is a powerful force in shaping a person's sense of identity. It can lend vitality to existence and establishes the cyclical patterns of day, week, month and year. It is believed that work for which there is no economic gain, such as child care, care for the aged and voluntary work, also has its rewards and contributes to personal gratification.

Positive health effects of work

Two-way interaction

There is a continuous two-way interaction between a person and the physical and psychological working environment: the work environment may influence the person's health either positively or negatively and productivity is, in turn, influenced by the worker's state of physical and mental well-being. Work, when it is well-adjusted and productive, can be an important factor in health promotion, e.g. partially disabled workers may be rehabilitated by undertaking tasks suited to their physical and mental limitations and, in this way, may substantially increase their working capacity. However, the fact that work can have a positive influence on health has not yet been fully exploited; knowledge of work physiology and ergonomics needs to be further developed and applied to benefit worker's health.

Health hazards

When work is associated with health hazards, it may cause occupational disease, be one of the multiple causes of other disease or may aggravate existing ill-health of non-occupational origin. In developing countries, where work is becoming increasingly mechanized, a number of work processes have been developed that treat workers as tools in production, putting their health and lives at risk. The occupational health lessons learned during the Industrial Revolution should be borne in mind in planning for health in developing countries if such problems are to be avoided.

Unemployment

Job loss may adversely affect a worker's physiological and mental health. If unemployment persists, the person's health continues to decline and chronic disorders can appear. The mental and financial distress caused by the job loss can spread to other family members. In a developing country, job loss can have profound effects that spread beyond the worker's own family since, where there is limited paid employment, a person in a well-paid job exerts an important influence in the community. In addition to having an obvious economic influence and high social standing, such a worker may serve as a good source of health information and set an example with a healthy lifestyle. Loss of employment for such a person can also affect the immediate community as well as the person's family. A worker's health may also suffer well before the actual job loss. Both feelings of job insecurity and knowledge of impending job loss have been associated with mental and physical health complaints.

Similarly, those who have never had the opportunity to be employed, e.g. because of unavailability of jobs, have no chance to develop an identity or sense of belonging through work which is important for psychological and social well-being. Such people are not accessible to health messages in the workplace and may be unaware of the positive relationship between work and health. In addition, because they have a lot of free time, sometimes associated with anxiety and depression, the never-employed are more likely than those in employment to consume alcohol, cigarettes and drugs.

Health, workplace, economy and sustainable development

The most successful economies have demonstrated that workplaces designed according to good principles of occupational health, safety and ergonomics are also the most sustainable and productive. In addition, a healthy economy, high quality of products or services and long-term productivity are difficult to achieve in poor working conditions where workers are exposed to health and safety hazards.

Principle 1 of the Rio Declaration on Environment and Development (United Nations Conference on Environment and Development, Rio de Janeiro, 1992) states: "Human beings are at the centre of concern for sustainable development. They are entitled to a healthy and productive life in harmony with nature". Sustainable development is defined as a strategy to "meet the needs of the present world population without causing adverse effect on health and on the environment, and without depleting or

endangering the global resource base, hence without compromising the ability of future generations to meet their needs".

In terms of occupational health, the above principles mean the satisfaction of material needs through work and other production processes without causing danger to human health, the ecosystem, the resource base or the health of the community, either in the short term or the long term. Occupational health is a basic element and constitutes a social and health dimension of the principle of sustainable development.

Occupational health is at the centre of sustainable development in the following ways.

- The prevention of occupational accidents, injuries and diseases and the protection of workers against physical and psychological overload imply appropriate use of resources, minimizing the unnecessary loss of human and material resources.
- The objective of healthy and safe work environments calls for the use of safe, low-energy, low-toxic-emission, low-waste (green) technology, and in many countries occupational health legislation requires the use of the best available production technology.
- The occupational health approach may facilitate undisturbed production that increases the quality of products, productivity and process management and helps to avoid unnecessary loss of energy and materials and to prevent an unwanted impact on the environment.
- Many environmental hazards and burdens are derived from occupational settings, e.g. industry, agricultural practices, transportation and services. Those responsible for occupational health and safety are well informed of processes and agents that may be hazardous to the environment. Often this information is available to them from the earliest stage of a problem enabling primary prevention which is no longer possible once the hazardous elements are released into the general environment.
- The impact of occupational health on environmental protection from industry is likely to be both effective and cost-effective. In many industrialized countries there are moves to make closer links between occupational health and environmental health approaches.
- Occupational health services aim to ensure workers' health, safety, working capacity and well-being. A healthy, productive and well motivated workforce is the key agent for overall socioeconomic development. In addition, high-quality and productive work ensures healthy production of materials, goods and services and the consideration and practical implementation of the principles of sustainable development.
- Most environmental health hazards that have later been found to affect the health of the general population were first detected in the work environment. The occupational environment provides an early warning system for certain

environmental health hazards just as it also provides effective models for preventive action.

- For many adults the work environment is the most demanding environment in terms of physical, chemical, ergonomic or psychological stresses and physical workload. The principle of the Rio Declaration with regard to a healthy and productive life is particularly relevant to the work environment and calls for occupational health action.

- The state of the general environment and the ecosystem has an impact on the health of workers either directly or indirectly in several occupations, e.g. agriculture, mining, fishery and manufacturing. There is a two-way relationship between occupational health and safety on the one hand, and occupational health and sound environmental development on the other.

- Equally important for personal well-being and for socioeconomic development of communities and countries is an employment policy that ensures access to work for everyone and enables individuals to sustain themselves and their families. Highest possible employment is also a key factor in the safe, stable and sustainable social development of countries, while high unemployment rates and other associated problems endanger such development.

- In developing countries, the health and well-being of the family is critically dependent on the health and productivity of its working member, thus making several members of the community dependent on the health of the worker. In a situation where organized social protection is lacking, the loss of health, life or working capacity of such a key member of the family often means severe crisis for the rest of the family, affecting indirectly the well-being, health and economy of communities at large and of future generations.

Occupational health is a basic element and constitutes a social and health dimension of the principle of overall development. Occupational health practices constitute a set of key activities for such development.

Work as a factor in health promotion

WHO defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. According to the WHO Study Group on Early Detection of Health Impairment in Occupational Exposure to Health Hazards:

> Health ... connotes rather a way of functioning within one's environment (work, recreation, living). It not only means freedom from pain or disease, but also freedom to develop and maintain one's functional capacities. Health develops and is maintained through interaction between the genotype and the total environment. The work environment constitutes an important part of man's total environment, so health is to a large extent affected by work conditions.[1]

[1] *Early detection of health impairment in occupational exposure to health hazards. Report of a WHO Study Group.* Geneva, World Health Organization, 1975 (WHO Technical Report Series No. 571).

Health promotion was defined by the Ottawa Charter for Health Promotion, 1986, as:

> ... the process of enabling people to increase control over, and to improve, their health. To reach a stage of complete physical, mental and social well-being, an individual or group must be able to identify and to realize aspirations, to satisfy needs, and to change or cope with the environment. Therefore, health promotion is not just the responsibility of the health sector, but goes beyond healthy lifestyles to well-being.[2]

Health promotion is a continuum ranging from the treatment of disease to the prevention of disease including protection against specific risks, to the promotion of optimal health. Achieving optimal health includes: improving physical abilities in relation to sex and age; improving mental ability; developing reserve capacities; adaptability to changing circumstances of work and life and reaching new levels of individual achievement in creative and other work. In a work setting these health-indicators may be evaluated quantitatively by indices of absenteeism, job satisfaction and work stability.

Health protection and promotion activities in the workplace

National governments

National governments have an interest in workers' health partly because it has a direct influence on national productivity. Governments are responsible for establishing and maintaining safe working conditions and ensuring, through legislation, that occupational health services are provided for all workers in all branches of economic activity, including those in the public sector. Health promotion programmes are not usually a statutory requirement but occupational health services can provide a focus for their implementation.

Management

Those responsible for the management of a workplace have an interest in workers' health promotion for the same reason as national governments: healthy workers are essential for optimal productivity. In addition to the humanitarian value of improving workers' health, the economic value is therefore particularly important to employers. This is also true for self-employed workers as their productivity is often completely dependent on their own health.

The prime responsibility for health and safety in a workplace rests with the management, which therefore plays an essential role in the success of any health promotion programme. To ensure the success of a programme, management must allow the necessary resources and time to be dedicated to it, demonstrate its desire for employees to participate and be willing to accept suggestions from employees on what should be done. Management must also have sufficient appreciation of the need for health promotion and disease prevention to be able to assess the relative merits of various programmes, determine priorities and delegate responsibility for achieving programme success.

---

[2] Ottawa Charter for Health Promotion. First International Conference on health Promotion, Ottawa, Canada, 17–21 November 1986.

Workers

The worker stands to benefit from health promotion programmes by having a safe and healthy work environment, a convenient location to learn about and put into practice a healthy lifestyle, readily available opportunities for screening and health care and an opportunity ultimately to achieve optimal health. Health has an all-encompassing impact on the worker's life, by affecting his or her ability to interact with others, to work and to be self-reliant.

The worker's contribution to workplace health promotion is essential to any programme's success. Workers should be involved in the programme's design and encourage their co-workers to participate.

Workers' representatives and unions

The role of workers' representatives, organizations and unions is to negotiate with the management to ensure that appropriate health programmes are implemented and that an appropriate balance is achieved between the various health programmes. The workers' organizations should also ensure that certain principles be followed, e.g. confidentiality and non-discrimination.

Communities

Health is influenced by many factors outside the workplace. Consequently, health promotion for the workforce cannot be regarded solely as the responsibility of occupational health professionals. The community, through its primary health workers and public health professionals, has clear-cut responsibilities for individual and group health education as a means of health promotion. Wherever possible, health education programmes should be a joint activity of occupational and community health professionals. Mass media can also play an important role in health education.

In developing countries, particularly in rural areas and small workplaces, the primary health worker may be the sole provider of health protection and promotion services for both workers and the rest of the community.

Occupational health professionals

Health promotion is an essential part of the occupational health professional's mandate. Physicians, nurses, safety officers, health educators and PHC workers will play different roles in work place health promotion and should be trained accordingly e.g. the role of the occupational health nurse is to educate, screen and counsel workers, whereas that of an occupational hygienist is to assess the control of health hazards while keeping in touch with the development and progress of health promotion programmes.

Together with others, such as ergonomists, nutrition specialists and psychologists, occupational health professionals can:

- protect workers' health by controlling hazards in the workplace and by introducing ergonomics
- advise workers and managers on health promotion activities and on how to improve working conditions

- monitor the work environment and workers' health with a view to early identification of health risks and evaluation of the effectiveness of health protection and promotion programmes.

In many circumstances, in developing as well as developed countries, occupational health professionals can cover only a small proportion of workplaces and workers. In such cases, others responsible for providing health care for workers should recognize health promotion as one of their major tasks and should receive some training in occupational health.

MODULE 1

Work environment

1. OBJECTIVES

- Detect work hazards as related to occupation, work and work environment
- Inspect workplaces for the discovery of actual hazards and unsafe workers' behaviour
- Use simple methods and techniques for evaluation of work hazards and for testing control measures
- Report work and environmental hazards to concerned bodies
- Know principles of the control of work hazards and work environment and participate in selecting appropriate control measures and optimal use of available resources
- Participate in the management of work emergency plans and in first aid
- Educate workers on the principles of safe conduct at work
- Participate in investigating work complaints, compensation cases, rehabilitation, social welfare, etc.
- Coordinate with other professionals in the occupational multi-disciplinary team: safety officer and committee, occupational hygienist, physician and nurse, sanitarian, first aid attendant, plant engineer and foreman.

2. INTRODUCTION AND BASIC CONCEPTS

2.1 Occupational hygiene

This is the practice of assessment and control of environmental factors and stresses arising in or from the workplace, which may cause injury, sickness, impaired health and well-being or significant discomfort and inefficiency among workers or among the citizens of the community.

It encompasses the study of:

- toxicology
- industrial processes
- the chemical and physical behaviour of air contaminants
- environmental sampling techniques and statistics
- the design and evaluation of ventilation systems

- noise control
- radiation protection
- the health effects of occupational hazards.

Occupational/industrial hygienists use environmental monitoring and analytical methods to detect the extent of worker exposure and employ engineering, work practice controls and other methods to control potential health hazards. Occupational/industrial hygienists must work with physicians to develop comprehensive occupational health programmes and with epidemiologists to perform research on health effects.

2.2 Work-site analysis

This is an essential procedure that helps in determining what jobs and workstations are the sources of potential problems. During the work-site analysis: exposures, problem tasks and risks are identified and measured. The most-effective work-site analyses include all jobs, operations and work activities. The occupational/industrial hygienist inspects, researches or analyses how the particular chemicals or physical hazards at the work-site affect worker health. If a situation hazardous to health is discovered, he or she recommends the appropriate corrective action.

Example

An occupational/industrial hygienist might be asked to determine the composition and concentrations of air contaminants in a workplace where there have been complaints of eye, nose and throat irritation. The hygienist in this situation would also determine if the contaminant exposures exceeded the permissible exposure limits required by the national regulations and standards. If the problem was the result of airborne materials (a conclusion that might be reached in consultation with a physician or epidemiologist), then the hygienist would be responsible for selecting the techniques used to reduce or eliminate the exposure e.g. installing exhaust ventilation around the source of the air contaminants and isolating it from the general work area. Follow-up sampling to verify that the controls had been effective would also be the hygienist's responsibility.

3. RECOGNITION OF HEALTH HAZARDS

3.1 Inspection

This is the first step in the process leading to evaluation and control and entails the identification of materials and processes that have the potential to cause harm to workers.

Inspection of the workplace is the best source of directly relevant data about health hazards. There is no substitute for observation of work practices, use of chemical and physical agents, and the apparent effectiveness of control measures. The PHC worker should be able to recognize major and obvious health hazards and distinguish those that require formal evaluation by the industrial hygienist.

3.2 Potential health hazards

Air contaminants

These are commonly classified as either particulate or gas and vapour contaminants

(a) Particulate contaminants

- Dusts: solid particles generated by handling, crushing, grinding, colliding, exploding, and heating organic or inorganic materials such as rock, ore, metal, coal, wood and grain. Any process that produces dust fine enough to remain in the air long enough to be inhaled or ingested should be regarded as hazardous until proven otherwise.
- Fumes: formed when material from a volatilized solid condenses in cool air. In most cases, the solid particles resulting from the condensation react with air to form an oxide.
- Mists: liquid suspended in the atmosphere. Mists are generated by liquids condensing from a vapour back to a liquid or by a liquid being dispersed by splashing or atomizing.
- Aerosols: a form of a mist characterized by highly respirable, minute liquid particles.
- Fibres: solid particles whose length is several times greater than their diameter, e.g. asbestos.

(b) Gas and vapour contaminants

- Gases: formless fluids that expand to occupy the space or enclosure in which they are confined. They are atomic, diatomic or molecular in nature as opposed to droplets or particles, which are made up of millions of atoms or molecules. Through evaporation, liquids change into vapours and mix with surrounding atmosphere.
- Vapours: the volatile form of substances that are normally in a solid or liquid state at room temperature and pressure.

Chemical hazards

Harmful chemical compounds in the form of solids, liquids, gases, mists, dusts, fumes and vapours exert toxic effects by inhalation (breathing), absorption (through direct contact with the skin) or ingestion (eating or drinking). Airborne chemical hazards exist as concentrations of mists, vapours, gases, fumes or solids. Some are toxic through inhalation and some of them irritate the skin on contact; some can be toxic by absorption through the skin or through ingestion and some are corrosive to living tissue. The degree of worker risk from exposure to any given substance depends on the nature and potency of the toxic effects and the magnitude and duration of exposure.

Biological hazards

These exist in exposures to bacteria, viruses, fungi and other living organisms that can cause acute and chronic infections by entering the body either directly or through breaks in the skin.

Occupations that deal with plants or animals or their products, or with food and food processing may expose workers to biological hazards. Laboratory and medical personnel also can be exposed to biological hazards. Any occupations that result in contact with bodily fluids expose workers to biological hazards.

In occupations where animals are involved, biological hazards are dealt with by preventing and controlling diseases in the animal population as well as properly caring for and handling infected animals.

Also, effective personal hygiene, particularly proper attention to minor cuts and scratches especially on the hands and forearms, helps keep worker risks to a minimum. In occupations where there is potential exposure to biological hazards, workers should practice proper personal hygiene, particularly hand washing.

Hospitals should provide proper ventilation, proper personal protective equipment such as gloves and respirators, adequate infectious waste disposal systems and appropriate controls including isolation in instances of particularly contagious diseases, e.g. tuberculosis.

Physical hazards

These include excessive levels of noise, vibration, illumination and temperature, and ionizing and non-ionizing electromagnetic radiation.

Noise, for example, is a significant physical hazard, which can be controlled by:

- installing equipment and systems that have been engineered, designed and built to operate quietly
- enclosing or shielding noisy equipment
- making certain that equipment is in good repair and is properly maintained with all worn or unbalanced parts replaced
- mounting noisy equipment on special mounts to reduce vibration
- installing silencers, mufflers or baffles
- substituting quiet work methods for noisy ones, e.g. welding parts rather than riveting them
- treating floors, ceilings and walls with acoustic material to reduce reflected or reverberant noise
- erecting sound barriers at adjacent workstations around noisy operations to reduce worker exposure to noise generated at adjacent workstations
- increasing the distance between the source and the receiver, e.g. by isolating workers in acoustic booths, limiting workers' exposure time to noise and providing hearing protection.

Occupational hygiene regulations require that workers in noisy surroundings be periodically tested as a precaution against hearing loss.

Ionizing radiation can be controlled by:

- Reducing exposure time: danger from radiation increases with the amount of time one is exposed to it. The shorter the time of exposure the smaller the radiation danger.
- Increasing distance: a valuable tool in controlling exposure to both ionizing and non-ionizing radiation. Radiation levels from some sources can be estimated by comparing the squares of the distances between the worker and the source.
- Shielding: the greater the protective mass between a radioactive source and the worker, the lower the radiation exposure. Similarly, shielding workers from non-ionizing radiation can also be an effective control method.

In some instances, however, limiting exposure to or increasing distance from certain forms of **non-ionizing radiation**, e.g. lasers, is not effective. An exposure to laser radiation that is faster than the blinking of an eye can be hazardous and would require workers to be miles from the laser source before being adequately protected.

Radiant heat exposure can be controlled by: installing reflective shields and by providing protective clothing in factories such as steel mills.

Ergonomic hazards

The science of ergonomics studies and evaluates a full range of tasks including, but not limited to, lifting, holding, pushing, walking and reaching.

Many ergonomic problems result from technological changes:

- increased assembly line speeds
- adding specialized tasks
- increased repetition.

Some problems arise from poorly designed job tasks. Any of those conditions can cause ergonomic hazards:

- excessive vibration
- noise
- eye strain
- repetitive motion
- heavy lifting problems
- poorly designed tools or work areas.

Repetitive motions or repeated shocks over prolonged periods of time as in jobs involving sorting, assembling and data entry can often cause irritation and

inflammation of the tendon sheath of the hands and arms, a condition known as carpal tunnel syndrome. Ergonomic hazards are avoided primarily by the effective design of a job or job-site and by better designed tools or equipment that meet workers' needs in terms of physical environment and job tasks.

Through thorough work-site analyses, employers can set up procedures to correct or control ergonomic hazards by:

- using the appropriate engineering controls, e.g. designing or redesigning work stations, lighting, tools and equipment
- teaching correct work practices, e.g. shifting workers among several different tasks, reducing production demand and increasing rest breaks
- providing and mandating personal protective equipment where necessary.

Evaluating working conditions from an ergonomic standpoint involves looking at the total physiological and psychological demands of the job on the worker. Overall, the benefits of a well-designed, ergonomic work environment can include increased efficiency, fewer accidents, lower operating costs and more effective use of personnel.

Psychosocial factors

These may include boring, repetitive tasks, production pressure, stress, low pay and lack of recognition.

Accident factors

The main causes of accidents include:

- unsafe mechanical and physical conditions
- unsafe acts
- unsafe personal factors.

3.3 Techniques used in recognizing health hazards

Material inventory

A material inventory is used for keeping an account of raw materials, intermediate and end products, waste products and by-products. It is tailored to meet the specific requirements of local circumstances taking into consideration the following.

(a) Who will use the inventory

- safety advisers and representatives
- occupational hygienists
- doctors
- nurses
- emergency service personnel
- purchasing staff.

(b) What information is required

- the nature of the material, i.e. composition, physical data, fire and explosion data, basic toxicological and safety data, etc.
- the use of the material, including storage, handling and control procedures, first aid, etc.
- administrative details, i.e. trade and chemical names, company reference numbers, address of manufactures/suppliers, labelling and packing requirements, waste disposal, etc.

(c) How the inventory will be updated

- any new substances should be considered from a health and safety viewpoint before purchasing, use and inclusion in the inventory
- for existing materials, health and safety staff should have a system for ensuring, through their information sources, that the hazard data contained in the data sheet is the best information currently available
- the availability of computerized data-handling systems augments the use of a materials inventory.

Process inventory

The aim is to document hazards associated with each process and to record how each is being managed and controlled. The process inventory should include details of:

- the process
- the materials involved (including intermediate and wastes)
- points of material entry and exit
- normal operating procedures
- potential hazards
- the potential for emissions into the atmosphere
- the potential for exposure
- arrangements for engineering controls
- other precautions including protective equipment.

The process inventory also provides the opportunity to document hazards other than those associated with chemicals, e.g. heat, noise and radiation, and to include disposal procedures for hazardous waste products.

The inventory could be based on:

- flow of a particular product or material
- departmental or equipment flow
- geographic location.

Walk-through occupational hygiene survey

A walk-through survey of the premises permits observation of all plant operations and is carried out to make a preliminary assessment of potential hazards. Possible sources and potential contaminants from specific types of processes can be identified (see appendix 1.1). The walk-through survey provides an important opportunity to meet plant personnel and to interact with engineers, foremen and other workers who know the process problems and are aware of complaints or symptoms among workers.

(a) General principles addressed by the walk-through survey

- hazards present in the work place
- estimated/likely scale of the identified hazards
- the control measures currently in force for each hazard
- procedures implemented to maintain the control measures
- the monitoring required.

(b) Survey methods

- Surveys are usually carried out without the use of measuring instruments.
- Much of the information required can be assembled in advance of the survey (see an occupational/industrial survey check list in appendix 1.2).
- The following aids are required to carry out the work:
  - survey report forms
  - notepad or dictation machine
  - plan of premises
  - camera
  - smoke tubes.
- The occupational hygienist (or whoever is nominated to undertake the task by the PHC workers) proceeds through each of the work areas, preferably in accordance with the working functions, often commencing with production from goods inward to dispatch, and preferably accompanied in each area of the premises by either a local supervisor or engineer with general responsibilities.
- Sources of information used during the survey are:
  - workers involved in their daily tasks
  - senses of smell, hearing and touch for detection of odours, heat and noise
  - photography for documenting the general visual appearance of each environment and any activity deserving further attention
  - smoke tube test for local exhaust ventilation
  - observation, the key to an effective survey, noting any ergonomics problems, e.g. poorly designed lighting, unsafe working practices, unguarded equipment, etc.

(c) Reports

The report should be written clearly and concisely and should be structured as follows:

- introduction
- summary of immediate hazards and action taken or recommended to resolve the problem permanently and/or temporarily pending further evaluation
- summary of hazards requiring further monitoring/evaluation
- walk-through survey report forms as completed during survey
- discussions of methods arising from survey
- proposed occupational hygiene work plan.

(d) Summary of a survey

- a survey is a preliminary assessment designed to identify hazards and control measures, carried out by competent staff with the help of local supervising staff
- it should be comprehensive by location and by time for cyclical/occasional processes
- it is a necessary prelude to detailed investigations of specific hazards
- it is necessary to gather a range of data pertaining to the subject in order to fully prepare for the survey
- the two main elements of the survey data source are the workforce and observation
- photography is very important
- reports should be structured carefully and be concise.

Air-sampling programmes

An air-sampling programme must be designed to answer specific questions otherwise it may not fulfil the need for which it was initiated, e.g. a prospective epidemiological programme requires random sampling in order for statistical predictions to be valid. Sampling for worker protection, on the other hand, will require selection of persons at maximum risk.

Reasons for sampling are varied and may include the following:

- health risk evaluation: to measure worker exposure in order to estimate the risk of undesirable health effects and the need for control measures
- environmental protection: to determine the amount of any toxic or hazardous materials released to the environment
- compliance: to ensure that exposure levels for workers or environmental releases are within regulatory limits and to satisfy legislative monitoring requirements

- process control: to evaluate the performance of engineering or other process controls and to ensure that contaminant control remains adequate
- source identification: to find and control contaminant sources
- documentation of exposure: to maintain records of exposure for prospective studies or for institutional protection against future legal action.

The sampling strategy for each of the stated purposes will require different protocols and sampling systems. The types of samples refer to whether a personal exposure sample should be collected in the breathing zone of a worker, or whether an area, stack or other environmental sample is preferable. Sampling from exhaust stacks is commonly done for process and emission control. Health protection requires personal exposure monitoring.

Occupational hygiene sampling protocols

Purpose	*Type of sample*
Health risk evaluation	Personal
Environmental protection	Area, environmental
Compliance	Personal, environmental, stack
Process control	Area, personal, stack
Source identification	Area, stack
Documentation of exposure	Personal

4. EVALUATION OF HEALTH HAZARDS

Evaluation of health hazards within a plant includes measurement of exposures (and potential exposures), comparison of those exposures to existing standards and recommendation of controls if needed.

4.1 Exposure measurement techniques

These techniques are based on the nature of hazards and the routes of environmental contact with the worker, e.g.

- air sampling can show the concentration of toxic particulates, gases and vapours that workers may inhale
- skin wipes can be used to measure the degree of skin contact with toxic materials that may penetrate the skin
- noise dosimeters record and electronically integrate workplace noise levels to determine total daily exposure.

Selection and calibration of instruments

Instruments are generally classified as follows:

- direct reading instruments
- sampling instruments which remove the contaminant (for subsequent laboratory analysis) from a measured quantity of air

- sampling instruments which collect a known volume of air for subsequent laboratory analysis.

All these types of equipment must be calibrated against a standard air flow measuring device before and after use in the field. Furthermore, direct reading instruments must be calibrated against a known concentration of the substance for which they are used.

Establishing proper analytical methods

The use of accurate, sensitive, specific and reproducible analytical methods is as important as the proper calibration of the sampling equipment. Among difficulties that should be overcome in the measurements (sampling/analysis) are:

- interference and reactions when dealing with mixtures of chemicals, which is often the case
- fluctuations in concentration.

Other factors affecting a worker's uptake of the contaminants include:

- routes of entry of material other than respiration, e.g. skin absorption
- physical activity of workers, which affects the respiration rate
- whether or not respirators are used in the workplace.

When available, standard methods of analysis should be used such as those recommended by:

- WHO
- International Organization for Standardization
- European Community
- American Industrial Hygiene Association (AHIA) Analytical Committee
- U.S. National Institute for Occupational Safety and Health (NIOSH)
- U.S. Occupational Safety and Health Administration (OSHA)
- American Conference of Governmental Industrial Hygienists (ACGIH)
- The American Public Health Association (APHA)
- The American National Standards Institute (ANSI).

Strategy of sampling and measurement

Every effort must be made to get measurements (or samples) that represent the workers' exposures. This is achieved by answering the following:

- Where to sample?
- Whom to sample?
- How long to sample?

- How many samples to take?
- When to sample?

A sufficient number of samples must be collected or readings made with direct reading instruments, for the proper duration, to permit the assessment of daily, time-weighted average (TWA) exposures and to evaluate peak exposure concentrations when needed.

4.2 Interpretation of findings

A great deal of judgement must be used in interpretation and reporting the results. The investigator must have the following facts:

- nature of substance or physical agents
- intensity (concentration) of exposure
- duration of exposure.

The hygienist's decision on whether a hazard is present is based on three sources of information:

- scientific literature and various exposure limit guides
- the legal requirements of the national occupational health and safety regulations
- interactions with other health professionals who have examined the exposed workers and evaluated their health status.

Occupational exposure limits refer to airborne concentrations of substances conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effect. They are based on available information from industrial experience, from experimental human and animal studies; and, when possible, from a combination of the three

4.3 Recommended exposure limits

Many standards have been recommended by different national and international agencies. The most popular and comprehensive however are the list of threshold limit values (TLVs) for chemical substances and physical agents and the biological exposure indices (BEIs) issued by the American Conference of Governmental Industrial Hygienists (ACGIH).

There are three categories of TLV:

- Time-weighted average (TWA8): the employee's average airborne exposure in any 8–hour work shift of a 40–hour work week, which shall not be exceeded.
- Short-term exposure limit (STEL): the employee's 15–minute TWA exposure, which shall not be exceeded at any time during a work day unless another time limit is specified in a parenthetical notation below the limit. If another time period is specified, the TWA exposure over that time limit shall not be exceeded at any time over a work day.

- Ceiling-C: the employee's exposure, which shall not be exceeded during any part of the work day. If instantaneous monitoring is not feasible, the ceiling shall be assessed as a 15–minute TWA exposure, which shall not be exceeded at any time over a work day.

Considerations are included for:

- skin notation (for probable skin absorption)
- mixtures (for exposure to mixtures of contaminants)
- total, inhalable, thoracic and respirable particulate matter
- Particulate not otherwise classified (PNOC)
- simple asphyxiates: inert gases or vapours
- Biological exposure indices (BEI)
- physical factors
- unusual work schedules.

5. CONTROLLING HAZARDS

Occupational/industrial hygienists recognize that engineering, work practice and administrative controls are the primary means of reducing employee exposure to occupational hazards.

5.1 Engineering controls

These minimize employee exposure by either reducing or removing the hazard at the source or isolating the worker from the hazard. They include:

- eliminating toxic chemicals and substituting non-toxic chemicals
- enclosing work processes or confining work operations
- installing general and local ventilation systems.

5.2 Work practice controls

These alter the manner in which a task is performed. Some fundamental and easily implemented work practice controls include:

- changing existing work practices to follow proper procedures that minimize exposures while operating production and control equipment
- inspecting and maintaining process and control equipment on a regular basis
- implementing good housekeeping procedures
- providing good supervision
- prohibiting eating, drinking, smoking, chewing tobacco or gum and applying cosmetics in regulated areas.

5.3 Administrative controls

These include:

- Controlling employees' exposure by scheduling production and tasks, or both, in ways that minimize exposure levels; e.g. the employer might schedule operations with highest exposure potential during periods when the fewest employees are present.
- When effective work practices or engineering controls are not feasible or while such controls are being instituted, appropriate personal protective equipment must be used, e.g. gloves, safety goggles, helmets, safety shoes, protective clothing and respirators. To be effective, personal protective equipment must be individually selected, properly fitted and periodically refitted, conscientiously and properly worn, regularly maintained and replaced as necessary.

6. TASKS FOR TRAINEES

- Acquaint yourself with local industries, occupations, workers' population and available occupational health and safety services, etc.
- Survey workplaces (using the walk-through method) in formal and informal sectors, agriculture, small-scale industries and other trades; familiarize yourself and collect data on technical operations, materials processed and handled, labour; and try to discover and define hazards.
- Report and refer hazards to concerned bodies and follow-up on their actions.
- Assess environmental hazards using simple, conventional methods and direct reading instruments; inspect available control measures and equipment and test their efficiency (e.g. using smoke tubes); and seek advice for interpretation of results and making suggestions for controls.
- Participate in data collection and analysis on workers' health.
- Be ready to help in an emergency and be able to administer first aid.
- Coordinate with other professionals in areas such as:
  - workers' education
  - investigating complaints
  - vocational rehabilitation
  - workers' social welfare
  - other matters relevant to optimal work place and work environment and to workers' health.

APPENDIX 1.1 POTENTIALLY HAZARDOUS OPERATIONS AND ASSOCIATED AIR CONTAMINANTS[1]

Process types	*Contaminant type*	*Contaminant examples*
Hot operations		
Welding	Gases (g)	Chromates (p)
Chemical reactions	Particulates (p)	Zinc and compounds (p)
Soldering	(Dust, fumes, mists)	Manganese and compounds (p)
Melting		
Moulding		
Burning		
Liquid operations		
Painting	Vapours (v)	Benzene (v)
Degreasing	Gases (g)	Trichlorethylene (v)
Dipping	Mists (m)	Methylene chloride (v)
Spraying		1,1,1-Trichloroethylene (v)
Brushing		Hydrochloric acid (m)
Coating		Sulfuric acid (m)
Etching		Hydrogen chloride (g)
Cleaning		Cyanide salts (m)
Dry cleaning		Chromic acid (m)
Pickling		Hydrogen cyanide (g)
Plating mixing		TDI, MDI (v)
Galvanizing		Hydrogen sulfide (g)
Chemical reactions		Sulfur dioxide (g)
		Carbon tetrachloride (v)
Solid operations		
Pouring	Dusts	Cement
Mixing		Quartz (free silica)
Separation		Fibrous glass
Extraction		
Crushing		
Conveying		
Loading		
Bagging		
Pressurized spraying		
Cleaning parts	Vapours (v)	Organic solvents (v)
Applying pesticides	Dust (d)	Chlordane (m)
Degreasing	Mist (m)	Parathion (m)
Sand blasting		Trichloroethylene (v)
Painting		1,1,1-Trichloroethane (v)
		Methylene chloride (v)
		Quartz (free silica, d)
Shaping operations		
Cutting	Dusts	Asbestos
Grinding		Beryllium
Filing		Uranium
Milling		Zinc
Moulding		Lead
Sawing		
Drilling		

[1] Leidel NA, Busch KA, Lynch JR. *Occupational exposure sampling strategy manual.* Cincinnati, Ohio, US Department of Health, Education and Welfare, 1977:77–173.

APPENDIX 1.2 AN OCCUPATIONAL HYGIENE SURVEY CHECK LIST

1. Determine purpose and scope of study:

- ♦ Comprehensive occupational hygiene survey?
- ♦ Evaluation of exposures of limited group of workers to specific agents?
- ♦ Determination of compliance with specific recognized standards?
- ♦ Evaluation of compliance with specific recognized standards?
- ♦ Response to specific complaint?

2. Discuss purpose of study with appropriate representatives of management and labour.

3. Familiarize yourself with plant operations:

- ♦ Obtain and study process flow sheets and plant layout.
- ♦ Compile an inventory of raw materials, intermediates by-products and products.
- ♦ Review relevant toxicological information.
- ♦ Obtain a list of job classifications and the environmental stresses to which workers are potentially exposed.
- ♦ Observe the activities associated with job classification.
- ♦ Review reports of previous studies.
- ♦ Determine subjectively the potential health hazards associated with plant operations.
- ♦ Review adequacy of labelling and warning.

4. Prepare for field study:

- ♦ Determine which chemical and physical agents are to be evaluated.
- ♦ Estimate, if possible, ranges of contaminant concentrations.
- ♦ Review, or develop if necessary, sampling and analytic methods, paying particular attention to the limitations of the methods.
- ♦ Calibrate field equipment as necessary.
- ♦ Assemble all field equipment.
- ♦ Obtain personal protective equipment as required (hard hat, safety glasses, hearing protection, respiratory protection, safety shoes, coveralls, gloves, etc.).
- ♦ Prepare a tentative sampling schedule.

- Review occupational health and safety regulations being applied by the health authorities.

5. Conduct field study:

- Confirm process operating schedule with supervisory personnel.
- Advise representatives of management and labour of your presence in the area.
- Deploy personal monitoring or general area sampling units.
- For each sample, record the following data:
  - sample identification number
  - description of sample (as detailed as possible)
  - time sampling began
  - flow rate of sampled air (check frequently)
  - time sampling ended
  - any other information or observation that might be significant (e.g., process upsets, ventilation system not operating, use of personal protection)
- Dismantle sampling units.
- Seal and label adequately all samples (filters, liquid solutions, charcoal or silica gel tubes, etc.) that require subsequent laboratory analyses.

6. Interpret results of sampling programme:

- Obtain results of all analyses.
- Determine time-weighted average exposures of job classification evaluated.
- Determine peak exposures of workers.
- Determine statistical reliability of data, e.g. estimate probable error in determination of average exposures.
- Compare sampling results with applicable industrial hygiene standards and regulations.

7. Discuss survey results with appropriate representatives of management and labour.

8. Implement corrective action comprised of, as appropriate:

- Engineering controls (isolation, ventilation, etc.).
- Administrative controls (job rotation, reduced work time, etc.).
- Personal protection.
- Biologic sampling programme.
- Medical surveillance.
- Education and training.

9. Determine whether other health and safety considerations warrant further evaluation:

- Air pollution?
- Water pollution?
- Solid waste disposal?
- Safety?
- Health physics?

10. Schedule return visit(s) to evaluate effectiveness of controls:

- Walk-through and observation.
- Measurements.

MODULE 2

Occupational and other work-related diseases

1. OBJECTIVES

- Understand the relationship between work and health
- Understand the interaction of man, environment and work
- Know the various types of stresses or hazards that may be present in different types of occupations including industry, agriculture etc.
- Know the concept of occupational and work-related diseases and the concept of aggravation
- Recognize general health problems of workers and whether or not they are work-related
- Survey the workplace, recognize signs and symptoms of early impairment of health and carry out simple tests to support the diagnosis of an occupational and/or work-related disease
- Give advice to management regarding the control and prevention of the identified hazards
- Give advice to workers and educate them regarding the nature of hazards they are exposed to, control measures, personal hygiene, early symptoms and first aid
- Refer patients and affected workers for further investigation and treatment
- Consult with the related authority on environmental monitoring of the workplace and on implementation and maintenance of control measures (especially engineering)
- Know the laws, rules and regulations governing occupational safety and health including hazard control at the workplace, recommended standards and threshold limit values, pre-placement and periodic medical examinations, schedule of occupational diseases (as applicable), insurance and compensations for occupational disease and accidents
- Keep medical records including personal medical files, records of accidents and occupational diseases, records of pre-placement and periodic examinations
- Keep records of environmental monitoring, safety activities, workplace surveys and report on health and safety trends at the workplace.

2. INTRODUCTION AND BASIC CONCEPTS

2.1 Occupational and work-related disease

"Occupational diseases … stand at one end of the spectrum of work-relatedness where the relationship to specific causative factors at work has been fully established and the factors concerned can be identified, measured, and eventually controlled. At the other end [are] diseases [that] may have a weak, inconsistent, unclear relationship to working conditions; in the middle of the spectrum there is a possible causal relationship but the strength and magnitude of it may vary."[1]

2.2 Degree of work-relatedness

The degree of work-relatedness of a work-connected disease condition varies in different situations and determines whether a disease is considered an occupational disease, a work-related disease or aggravation of a concurrent disease, e.g.

- A specific agent like lead or silica, which is present essentially in the workplace, causes a disease condition which cannot occur due to other causes; this is an occupational disease.
- Where infection can occur at the workplace, an occupational disease can also be caused by a specific agent, such as tuberculosis among health care workers in a tuberculosis treatment centre. Of course infection can also occur in the general population under non-occupational conditions.
- Work-related diseases occur much more frequently than occupational diseases. They are caused by the interaction of several extrinsic risk factors and a number of intrinsic factors each of which may or may not operate in any individual case. Occupational hazards are among the risk factors which can contribute to the occurrence of work-related diseases. Examples are many and include:
  - behavioural responses
  - psychosomatic illness
  - hypertension
  - coronary heart disease
  - chronic non-specific respiratory disease
  - locomotor disorders.
- Work conditions can aggravate pre-existing disease: hepatic dysfunction can be aggravated by exposure to certain chlorinated hydrocarbons; bronchial asthma can be aggravated by dust exposure and renal disease can be aggravated by inorganic mercury, cadmium and certain solvents.

[1] *Identification and control of work-related diseases.* Report of a WHO Expert Committee (WHO Technical Report Series No. 714), Geneva, World Health Organization, 1985.

- Exposure to combinations of occupational hazards may result in synergistic effects which are much more pronounced than effects of individual exposures simply added together.
- Individual susceptibility to the effects of some occupational exposures varies. Genetic factors are important determinants of individual susceptibility.

3. OCCUPATIONAL DISEASES

3.1 Definition

Occupational diseases are adverse health conditions in the human being, the occurrence or severity of which is related to exposure to factors on the job or in the work environment. Such factors can be:

- Physical: e.g. heat, noise, radiation
- Chemical: e.g. solvents, pesticides, heavy metals, dust
- Biological: e.g. tuberculosis, hepatitis B virus, HIV
- Ergonomic: e.g. improperly designed tools or work areas, repetitive motions
- Psychosocial stressors: e.g. lack of control over work, inadequate personal support
- Mechanical: these mainly cause work accidents and injuries rather than occupational diseases.

3.2 Characteristics of occupational diseases

The occupational cause of occupational disease is often overlooked by health care providers. This is due to several special characteristics of occupational disease that may obscure its occupational origin.

- The clinical and pathological presentation of most occupational diseases is identical to that of non-occupational diseases; e.g. asthma (excessive airway narrowing in the lungs) due to airborne exposure to toluene diisocyanate is clinically indistinguishable from asthma due to other causes.
- Occupational disease may occur after the termination of exposure. An extreme example would be asbestos-related mesothelioma (a cancer affecting the lung and abdomen) which can occur 30 or 40 years after the exposure.
- The clinical manifestations of occupational disease are related to the dose and timing of exposure; e.g. at very high airborne concentrations, elemental mercury is acutely toxic to the lungs and can cause pulmonary failure, while at lower levels of exposure, elemental mercury has no pathologic effect on the lungs but can have chronic adverse effects on the central and peripheral nervous systems.
- Occupational factors can act in combination with non-occupational factors to produce disease; e.g. exposure to asbestos alone increases the risk of lung

cancer five-fold; and the long-term smoking of cigarettes increases the risk of lung cancer between 50 and 70 fold.

3.3 Prevention of occupational diseases

Primary prevention

Primary prevention is accomplished by reducing the risk of disease. In the occupational setting, this is most commonly done by reducing the magnitude of exposure to hazardous substances. As the dose is reduced so is the risk of adverse health consequences. Such reductions are typically managed by industrial hygiene personnel and are best accomplished by changes in production process or associated infrastructure, e.g. the substitution of a hazardous substance with a safer one, or enclosure or special ventilation of equipment or processes that liberate airborne hazards. These are known as engineering controls.

Other methods of exposure reduction include use of personal protective equipment and rotation of workers through areas in which hazards are present to reduce the dose to each worker (NB: this method does, however, increase the number of workers exposed to the hazard).

Secondary prevention

This is accomplished by identifying health problems before they become clinically apparent (i.e. before workers report feeling ill) and intervening to limit the adverse effects of the problem. This is also known as occupational disease surveillance. The underlying assumption is that such early identification will result in a more favourable outcome.

An example of secondary prevention is the measurement of blood lead levels in workers exposed to lead. An elevated blood lead level indicates a failure of primary prevention but can allow for corrective action before clinically apparent lead poisoning occurs. Corrective action would be to improve the primary prevention activities listed above.

Tertiary prevention

This is accomplished by minimizing the adverse clinical effects on health of a disease or exposure. Typically this is thought of as clinical occupational medicine. An example of tertiary prevention is the treatment of lead poisoning (headache, muscle and joint pain, abdominal pain, anaemia, kidney dysfunction) by administration of chelating medication. The goal is to limit symptoms or discomfort, minimize injury to the body and maximize functional capacity.

3.4 Physical hazards at the workplace

Thermal stress

(a) Thermal environment

The temperature of the human body when healthy is at a constant of around 37 ˚C through a dynamic balance between heat production and heat loss. The heat regulating centre in the hypothalamus controls this balance.

Heat is produced by the metabolic processes, by muscular activity and by food consumption. Heat is exchanged with the surrounding environment by conduction, convection, radiation and evaporation of sweat. Heat exchange is influenced by air temperature, air velocity, relative humidity and radiation. Various combinations of these factors can cause different degrees of comfort and discomfort and several indices have been described to express the degree of thermal stress resulting from combinations of these factors, e.g. the effective temperature, the corrected effective temperature and wet-bulb-globe temperature indices.

(b) Types of thermal stress

Cold stress:

This exists when the surrounding temperature falls, as occurs when entering cold storage rooms. A human tries to reduce the exposed skin surface (by bending the joints if possible or by wearing thick woollen clothes). Peripheral vasoconstriction of skin vessels occurs resulting in vascular injury, chilblains, frost bite (dry gangrene) or trench foot (wet gangrene). Heat production increases through increased muscle tone and shivering. Extreme cases result in hypothermia, lowering of the temperature of core organs and death.

Heat stress: the stages

Vasomotor control: As the heat stress increases, more blood is pumped to the skin and less to the visceral organs and brain. There is cardiovascular stress and tachycardia. Muscular work is reduced since it produces more heat. Heat exhaustion is manifested by headaches, dizziness, sleepiness, lack of concentration and anorexia.

Evaporative cooling: The body starts to sweat with the amount related to the degree of stress and acclimatization. Loss of sodium chloride through sweating causes heat cramps (painful cramps starting in the working muscles and spreading to other muscles) and dehydration which aggravates cardiovascular problems. The volume of urine is reduced. High air velocity and low relative humidity help cooling through the evaporation of sweat. Dry heat exposure is encountered in foundries, steel mills and in the glass industry and moist heat exposure in textile mills, mines, the food canning industry and laundries.

Heat stroke: If sweating is not sufficient to keep the body temperature within the physiological range, the heat regulating centre fails, sweating stops, the skin is flushed and the patient is said to suffer from heat stroke. Unconsciousness and death may follow. Heat stroke occurs in workers in hot humid environments especially when exposed to direct sunlight. It is an emergency situation where rapid cooling, rehydration and replacement of electrolytes are indicated.

(c) Prevention of heat stress

A gradual exposure to a hot environment results in acclimatization and better tolerance. Heat stress is especially dangerous for children, the elderly and patients with cardiovascular, renal and skin diseases.

Engineering control measures should be used to prevent heat exposure including shielding, insulation and ventilation. Pre-placement and periodic medical examinations are important; lost fluids and sodium chloride should be replaced; personal protective clothes can help in some situations and workers should be given adequate rest periods to be spent in a more comfortable environment.

Noise

Noise is unwanted sound. Workers are exposed to noise in:

- textile and glass industries
- ship building
- aeroplane manufacture
- engineering industries
- manufacture of boilers and pressure vessels
- power plants.

Sound is propagated in the form of waves, each of which can be described in terms of frequency or number of cycles per second measured in hertz (Hz) and intensity as expressed in decibels (dB). The human ear can hear sounds ranging in frequency from 20 Hz to 20 000 Hz. The intensity of very faint sounds is around 0 dB and a jet engine can produce sounds of 130 dB, which is painful to the ear. The sounds we normally hear are complex sounds formed from many waves of varying frequencies and intensities. Ordinary speech is heard at frequencies of 500 Hz to 2000 Hz.

In addition to interference with the hearing of normal speech, noise can cause annoyance and stress and can lead to increased accident rates and lower productivity. Extra-auditory effects are observed in different systems, including endocrine, gastrointestinal and cardiovascular systems, and interfere with sleep.

The most important effect of exposure to noise is noise-induced hearing loss (NIHL). Hearing impairment is at first temporary; as exposure to noise (about 85 dB) continues, hearing impairment becomes permanent. NIHL usually takes many years (7–10 years) to develop. The most hazardous is high intensity, high frequency, continuous noise. Personal susceptibility has a definite effect.

Audiometry reveals early hearing impairment at frequencies of 3000–6000 Hz before hearing of normal speech is affected. Hence, the importance of measurement of hearing on pre-placement and periodic hearing examinations.

Measures to control noise in the workplace include:

- design and maintenance of machinery
- segregation and dispersion of noise sources

- prevention of propagation and reflection of noise by the use of sound proofing materials for floors, walls and ceilings
- rotation of workers
- reduction of work exposure hours
- use of personal protective devices, e.g. ear plugs, ear muffs and helmets.

Vibration

Workers exposed to whole vibrations include tractor drivers, transport workers, workers involved in drilling for petroleum and those in the textile industry. Whole body vibrations cause various ailments related to congestion of pelvic and abdominal organs.

Segmental vibrations affect workers using pneumatic or electrical vibrating tools in mining, road construction, shoe manufacture and sawing. Vascular changes in the upper limbs lead to "dead hands" and "white fingers" and prolonged exposure leads to rarefaction in the small bones and wrist.

Poor or defective illumination

Lighting standards depend on the type of work performed and degree of precision required. Adequate lighting should be provided either by natural or artificial means, avoiding shadows and glare and observing appropriate colours and contrast.

Defective illumination leads to eye strain, fatigue and increased accident rates. Defective illumination in miners leads to miner's nystagmus (rapid, involuntary movement of the eyes).

Radiation

(a) Non-ionizing radiation

Ultraviolet radiation

Exposure occurs in welding, metal cutting and exposure to carbon arc and causes skin erythema, burns and hyperpigmentation. Exposure of the eyes causes "arc eye" with conjunctivitis and severe pain and may lead to corneal ulceration. Eye protection using special face shields is necessary. Prolonged exposure causes atrophy of the skin and epitheliomas.

Infrared radiation

Exposure occurs in front of furnaces, in steel mills, in the glass industry, in blacksmiths and in chain manufacture. Exposure of the eyes can cause cataracts or corneal affection. Skin burns can also occur. Complete protection of the eyes can be achieved by wearing special goggles.

(b) Ionizing radiation

Sources of radiation include radioactive isotopes and X-ray machines. Ionizing radiation is used in medicine, industry, agriculture, research and atomic warfare. Radiations are either electromagnetic waves, like X-rays and gamma-rays, or minute

particles, like alpha, beta and neutrons. Both types cause ionization or excitation of atoms which leads to tissue destruction.

The effect of ionizing irradiation depends on the dose, type of radiation, whether exposure was continuous or interrupted and whether it was total body or localized, as well as the type of tissue irradiated. The power of penetration of different types of radiation varies from very high, such as X-ray and gamma-ray radiation, to very low, such as alpha radiation.

Different tissues vary in their sensitivity to radiation, with the tissues of the haemopoietic system and the gastrointestinal mucosa being the most sensitive and those of the bones and muscles being the least sensitive.

Effects may vary:

- Death occurs within hours if the whole body is exposed to a high dose.
- Acute radiation syndrome occurs if the dose is less. Signs and symptoms appear within 24–48 hours and are due to affection of the gastrointestinal mucosa causing severe bloody diarrhoea and shock of the haemopoietic system and of the skin. If death occurs it is due to haemorrhage (due to thrombocytopenia) or infection (due to damage of intestinal mucosa and leukopenia).
- Beta-radiation affects the skin only, causing skin burns and alopecia.
- Chronic radiation effects may follow long after an acute exposure or follow repeated exposure to doses not enough to cause acute effects.
- Chronic effects include skin atrophy, loss of finger prints, alopecia, nail changes, telaniectasia, pigmentation, keratoses and epitheliomas. Other effects include sterility, abortion, mutagenic effects and birth defects.

Control of exposure to external radiation sources rests on three general principles:

1. Keeping sufficient distance between source and worker.
2. Reducing time of exposure.
3. Containment and shielding.

Control of exposure to internal irradiation (uptake of radioactive materials) follows more stringent regulations.

Laboratories or establishments in which radioactive materials are handled should be constructed in such a way as to offer maximum containment, enclosure and shielding of radioactive material, and to ensure easy and complete cleaning in case of spills. Handling by remote control is very useful.

Ventilation and waste disposal systems should be separate from those of other areas and radioactive waste should not reach public waste systems. Radioactive waste should be disposed of in such a way that environmental contamination is not likely.

Environmental monitoring should be practised and alarm systems should be provided.

Other measures include:

- pre-placement and periodic medical examinations with special emphasis on eyes, skin and blood
- personal protective clothing
- personal monitoring badges
- pocket dosimeters
- whole body counters
- monitoring of radioactivity in biological fluids.

Changes in barometric pressure

(a) Increased barometric pressure

Workers exposed to increased barometric pressure are divers, frogmen, submarine crew and workers engaged in underwater construction of piers, bridges etc. Barometric pressure increases by 1 atmosphere for every 10 metres descended underwater.

During descent: if the openings leading to the paranasal sinuses or the middle ear are blocked (e.g. due to catarrh and oedema of a mucous membranes), the pressure in the cavities cannot be equalized with the outside pressure and this results in severe pain, oedema of the lining mucous membrane, haemorrhage and maybe rupture of the ear drum.

During the stay under water, because of the dissolution of excess amounts of gases in the blood and tissues, oxygen poisoning and nitrogen narcosis may occur with serious consequences. Divers may also suffer asphyxia and even drowning.

If rapid ascent occurs with the glottis closed (e.g. if the worker panics) the lung may rupture due to expansion of gases, especially in the presence of a weak spot. Rapid ascent, not following the recommendations of standard surfacing tables, results in the formation of gas bubbles in the blood and tissues due to liberation from solution of the excess gases that were dissolved under pressure. In the blood stream, gas (especially N_2) causes air embolism and paralysis and in tense tissues (ligaments around joints) causes severe pain known as “the bends”, also referred to as “Caisson disease” or decompression sickness.

Workers who work under increased pressure under water for many years may suffer from aseptic bone necrosis, especially in the head of the femur. Caisson disease may manifest within 24 hours of ascent and calls for urgent compression in a compression chamber until symptoms disappear. Pressure is then released according to recommended steps.

A worker with an upper respiratory infection should not be allowed to dive to avoid complications during descent.

(b) Reduced barometric pressure

Passenger planes are normally pressurized but military pilots may be exposed to reduced atmospheric pressure. In this case expansion of intestinal gases may cause respiratory embarrassment but before decompression sickness occurs they will have landed.

Workers at high altitude suffer from effects of reduced partial pressure of oxygen. The body compensates by increasing the pulse rate, increasing the breathing rate and polycythemia.

3.5 Chemical hazards (occupational poisoning)

Workers in different occupations are exposed to thousands of chemicals, some of which can cause occupational diseases. For the sake of discussion, these chemicals are classified according to their physical state, chemical composition or physiological action.

Gases and vapours

These can be classified according to their physiological action into: asphyxiants, irritant gases, organometallic compounds and anaesthetic vapours.

(a) Asphyxiants

Can cause asphyxia either by replacing oxygen or by some other mechanism. They are classified into: *simple asphyxiants* and *chemical asphyxiants*.

Simple asphyxiants: replace oxygen, e.g. nitrogen, methane, hydrogen and carbon dioxide.

Nitrogen: a simple asphyxiant used in the fertilizer industry and present in mines when O_2 is consumed. In mines it can be detected by the safety lamp which is extinguished at O_2 concentration of 17%. At 12% O_2 there is dyspnea, cyanosis, unconsciousness, loss of motor power, convulsions and death.

Methane (marsh gas): results from decomposition of organic matter and is present in marshes, sewers and mines. It is a simple asphyxiant, inflammable and lighter than air.

Carbon dioxide (CO_2): results from combustion of fuels; it is a colourless gas, heavier than air. It can be found in mines, wells, caves and close to furnaces and brick kilns. It is also present in the manufacture of soft drinks, beer, in the sugar industry and is used as dry ice. In addition it can be used to extinguish fires. CO_2 is a simple asphyxiant but in low concentrations stimulates rapid respiration. Resuscitation calls for O_2 inhalation, warmth, cardio-respiratory stimulants and if respiration stops, artificial respiration.

Chemical asphyxiants: interfere through some chemical action with the respiratory function of the blood, tissue cells or respiratory centre, e.g. carbon monoxide (CO), hydrogen sulfide and hydrocyanic acid.

Carbon monoxide (CO): a colourless, odourless gas which results from incomplete combustion of fuel. It is a product of coal distillation plants, steel furnaces, fuel boilers and furnaces and home heating appliances. It is also present in vehicle exhaust fumes.

CO has a great affinity to haemoglobin (HbCO) (210 times that of O_2) and thus interferes with O_2 transport. Exposure causes headaches, dizziness, chest oppression, loss of motor power, unconsciousness, convulsions, cardiovascular effects, coma and death (depending on the percentage of HbCO in the blood).

Prevention of CO poisoning depends on proper design, maintenance and regular inspection of home appliances and industrial sources and also on control measures in garages.

In a case of poisoning, O_2 inhalation is indicated (with 5% CO_2), with warmth, stimulants and artificial respiration provided if needed; the worker should be removed from exposure first.

Hydrogen sulfide (H_2S): a colourless gas, heavier than air; it has the odour of rotten eggs. Exposure occurs in oil fields and refineries, tanneries, sewers and in the manufacture of rayon and artificial rubber. It can be detected by its smell and causes paralysis of the olfactory nerve after a short while.

In addition to being a chemical asphyxiant, it has an irritant effect on the eyes and upper respiratory centre; it also causes asphyxia by combining with cytochrome oxidase enzyme and preventing tissue respiration. If respiratory paralysis occurs artificial respiration is indicated. Nitrites (sublingual and intravenous) serve to break the combination between the gas and cytochrome oxidase enzyme by forming methaemoglobin.

Hydrocyanic acid (HCN): a colourless gas that has the odour of bitter almonds. HCN is used in fumigation of ships as a pesticide and its salts are used in photography, metal hardening, electroplating and in extraction of gold from ore.

The gas can be absorbed through the skin and its inorganic salts are among the most potent poisons. They produce their effects through inhibiting cytochrome oxidase enzyme thus interfering with tissue respiration. Signs and symptoms appear within minutes in the form of dizziness, oppression of the chest, cardio-respiratory manifestations, unconsciousness and death which, in severe cases, occurs within minutes. Organic salts are not as toxic.

First aid includes the inhalation of amyl nitrite and intravenous injection of sodium nitrite followed by sodium thiosulfate. Cobalt EDTA and hydroxocobalamin are also used in the treatment of cyanide poisoning. Cardio-respiratory stimulants, warmth and artificial respiration may also be indicated.

Since HCN is a very rapid poison, the first aid equipment should be very close to the work site and a well-trained first aid attendant available at all work shifts.

(b) Irritant gases

These can cause irritation or inflammation of the mucous membranes with which they come into contact. This property depends on their degree of solubility in water.

Highly soluble gases, like ammonia, affect the upper respiratory passages. Less soluble gases like chlorine and sulfur dioxide affect both the upper respiratory passages and the lung tissues. Gases which are even less soluble, like nitrogen oxides and phosgene, act essentially on the lungs and in this case the irritant affect may be delayed for hours.

Sulfur dioxide (SO_2): one of the most common air pollutants. It results from the combustion of fuels containing sulfur and is present in vehicle exhaust fumes, in front of furnaces and is also produced in the extraction of metals from sulphide ores. It is used in the production of sulfuric acid, in the preservation of fruits, in sugar industry and in the bleaching of wool.

It is colourless, has a pungent odour and is oxidized in air into sulfur trioxide.

Exposure causes irritation of the eyes and upper respiratory passages. High concentrations may cause oedema of the larynx, pulmonary oedema, pneumonia and even death.

Ammonia (NH_3): a common upper airway tract irritant. It is a highly soluble alkaline gas that is widely used in industry as a refrigerant and in the manufacture of fertilizers, explosives and plastics. It attacks the skin, the conjunctiva and the mucous membranes of the upper respiratory tract. Oedema of the larynx and pulmonary oedema can occur with exposure to high concentrations and can cause death.

Management consists of removing the patient from exposure followed by supportive care with oxygen and attention to fluid and electrolyte homeostasis. Most patients gradually improve over time and make a full recovery without parenchymal lung damage except for bronchiectasis.

Formaldehyde (HCHO): a potent upper respiratory tract irritant that is used as a disinfectant and industrial cleaner and may release gas from particle board. It is an animal carcinogen and may cause acute bronchial irritation in humans.

Hydrogen fluoride (HF): a potent upper respiratory tract acid irritant that causes pulmonary oedema. It is used in the microelectronics industry for etching silicon chips and is also used to etch glass.

Ozone (O_3): an important irritant produced by photochemical oxidation of vehicle exhaust fumes and which is generated in arc welding. Ozone causes nose and eye irritation and is also a potent respiratory tract irritant causing coughing, tightness in the chest and shortness of breath.

Chlorine (Cl_2): a greenish yellow gas with a pungent irritating odour. It affects the upper and lower respiratory tract. Exposure occurs in the production of sodium hydroxide. The gas is used in bleaching and water disinfection and exposure can occur during the transport of liquid chlorine. Exposure causes irritation of the eyes and upper respiratory tract and larger concentrations may result in pulmonary oedema and death.

Phosgene ($COCl_2$): results from decomposition of chlorinated hydrocarbons when they come into contact with a hot surface (CCl_4 is used in fire fighting). Phosgene is sparingly soluble in water, therefore upper respiratory irritation is slight. However,

delayed pulmonary oedema can occur and therefore the patient should be observed for 48 hours and given rest, warmth stimulants and O_2.

Nitrogen oxides (NO_x): nitrous oxide (N_2O) is an anaesthetic and in the absence of O_2 is a simple asphyxiant. Nitrogen oxides are a mixture of NO_2 and N_2O_4 and are brown in colour. Exposure occurs in chemical laboratories, in the explosive industry, in the manufacture of nitric or sulfuric acids, fertilizer industry and on slow combustion of nitrogen-containing materials. It is present in welding operations and in soils.

Due to their poor water solubility, nitrogen oxides can be inhaled in high concentration without sufficient warning irritation but it has a severe irritant effect on the lung tissue. Symptoms may be delayed 2–20 hours, after which fatal pulmonary oedema may occur. Therefore, regardless of the condition of the patient when first seen, he/she should be put under close observation, preferably in hospital, for at least 24 hours.

(c) Organometallic compounds

Arsine (ASH_3): produced during chemical treatment of metals when arsenic is present as an impurity and nascent hydrogen is evolved. It is colourless and has a garlic odour. Exposure results in haemolysis, anaemia, jaundice and anuria in severe cases.

Nickel carbonyl [$Ni(CO)_4$]: a volatile liquid produced during the extraction of nickel. Inhalation causes severe pulmonary irritation.

(d) Anaesthetic vapours

Many of these have some other systemic effect as well and tend to accumulate in low, closed, poorly ventilated places.

The following precautions should be observed when there is potential exposure to noxious gases.

- Workplaces should be ventilated or steamed repeatedly.
- If there is likelihood of the presence of noxious gases or insufficient oxygen, gas masks should be provided.
- Workers should be properly trained and should always work in teams with one team member nominated to observe from a distance, away from possible contamination.
- First aid equipment, including oxygen, should be readily available with a trained team of rescuers.
- An affected worker should be removed from the exposure and kept warm and rested. If breathing stops, artificial respiration should be continued until recovery or death is ascertained.

Metals

In industry, poisoning with metals usually takes the chronic form and results from the absorption of small amounts over long periods of time. Acute poisoning may result from accidental (or suicidal) intake of large doses of some of the more toxic compounds (like arsenicals).

Metals and their compounds gain access into the body by inhalation, ingestion and, in a few cases, through the skin. A large number of metallic compounds are used in industry with the following being some of the more important.

(a) Lead

Inorganic lead: Exposure to inorganic lead compounds occurs in mining, extraction, smelting, metal cutting, manufacture of lead pipes, lead paints, manufacture of lead batteries, crystal glass and hot metal typesetting.

It is absorbed as dust via the respiratory tract, and via the gastrointestinal tract with food and drinks. Inorganic lead is not absorbed through the skin. The signs and symptoms of exposure include a blue line on the gums, intestinal colic and constipation, anaemia, general weakness and, in severe cases, foot drop and wrist drop. Encephalopathy due to lead is now very rare.

Engineering control methods to prevent exposure are ventilation, mechanization and housekeeping. Personal cleanliness, change of clothes, washing facilities and provision of clean areas for eating and storing food will reduce uptake of lead by mouth. Periodic medical examination helps detect early affection.

Organic lead (tetraethyl lead): Organic lead is still used as a fuel additive in gasoline. It is a volatile liquid and can be absorbed by inhalation and through the skin. Exposure causes excitation of the central nervous system then depression and may end in death.

(b) Mercury

Mercury is a volatile liquid metal. Exposure occurs in mining, extraction, chemical laboratories, the chemical industry in general, the pharmaceutical industry, the manufacture of thermometers and barometers, the explosive industry, the manufacture of mercury vapour lamps, the manufacture of pesticides, mirrors and in dentistry.

Inorganic mercury compounds: cause stomatitis, a brown line on the gums, loose teeth, metallic taste, tremors and personality changes. There is kidney affection and gastrointestinal disturbances.

Organic mercury (pesticides): exert their effect on the central nervous system. Mercury fulminate (an explosive) causes skin ulcers and perforation of the nasal septum.

(c) Manganese

Exposure occurs in mining, extraction, the steel industry, the dry battery industry, the glass and ceramics industry, the manufacture of welding rods and in the chemical industry. Manganese exposure can cause pneumonia and can affect the

central nervous system causing Parkinson disease, tremors, mask face, rigidity and personality change.

(d) Arsenic

Exposure occurs in mining and extraction. Arsenic compounds are used in pesticides, wood preservatives, medicines, paints and the chemical industry. Acute exposure causes severe gastroenteritis, shock and even death. Chronic exposure to arsenic causes affection of the peripheral nerves, skin lesions, skin cancer, anaemia, perforation of the nasal septum and lung cancer.

Organic solvents

Organic solvents are organic liquids in which other substances can be dissolved without changing their chemical composition. They are used in the extraction of oils and fats in the food industry, the chemical industry, paint, varnishes, enamel, the degreasing process, dry cleaning, printing and dying in the textile and rayon industries. Organic solvents are volatile: many of them are inflammable and they are considered fire hazards.

Chemical groups include:

- hydrocarbon solvents
- alcohols and ethers
- ketones
- esters
- glycols and their compounds.

Solvents are absorbed mainly through the lungs, via the gastrointestinal tract if taken by mouth, and many of them can be absorbed via intact skin. As a group, solvents affect several of the body's systems and can cause the following effects:

- nervous system: dizziness, unconsciousness and death, peripheral neuritis, affection of vision, insomnia, headache and easy fatigue
- gastrointestinal system: dyspepsia, anorexia and nausea and may be secondary to liver affection
- respiratory tract: may show upper respiratory irritation in some cases
- kidney: affection may cause nephritis or renal failure
- blood forming organs: may be affected causing anaemia or even leukaemia
- skin: may show contact dermatitis or acne.

Specific examples of poisoning by organic solvents:

- Petroleum products: may cause unconsciousness and when swallowed by accident cause gastritis or pneumonia due to aspiration into lungs.
- Benzol (benzene, C_6H_6): is a product of coal distillation and is used in the paint industry, artificial rubber manufacturing, the pharmaceutical and chemical

industries, rubber products manufacturing and degreasing. The central nervous system toxicity is the most important aspect of acute high dose exposure to benzol. Aplastic anaemia is the classic cause of death in chronic benzol poisoning. Benzol-induced leukaemia may develop in some cases in persons who previously have had aplastic anaemia. The toxic effects of benzol are best prevented by replacing it with less toxic compounds. There are many solvents safer than benzol.

- Chlorinated hydrocarbons: the addition of chlorine to carbon and hydrogen increases the stability and decreases the flammability of the resulting compounds. They have slightly pungent odours. Six chlorinated aliphatic hydrocarbons are commonly used as solvents:
  - trichlorethylene
  - perchloroethylene (tetrachloroethylene)
  - 1-1-1-trichloroethane (methyl chloroform)
  - methylene chloride (dichloromethane)
  - carbon tetrachloride
  - chloroform.

Acute effects include:

- anaesthesia: dizziness, headache, nausea, vomiting, fatigue, "drunkenness", slurred speech, disequilibrium, disorientation, depression, loss of consciousness
- respiratory tract irritation: sore nose, sore throat, cough.

Chronic effects include: dermatitis, neurobehavioural dysfunction, hepatocellular injury and renal tubular dysfunction.

Pulmonary dust diseases

If the work atmosphere is dusty, dust will inevitably be inhaled. Dust particles below five microns in diameter are called respirable since they have the chance to penetrate to the alveoli. The respiratory tract has certain defence mechanisms against dust but when the environment is very dusty a significant amount of dust can be retained in the lungs.

Different kinds of dust have different effects:

- Soluble particles of toxic compounds reach the blood and cause poisoning, e.g. lead.
- Irritant dusts cause irritation of the upper respiratory tract and the lungs and certain metal fumes cause chemical pneumonia, e.g. cadmium, beryllium and manganese.
- Some others cause sensitization resulting in asthma or extrinsic allergic alveolitis, e.g. some organic dusts.
- Metal fume fever is caused by inhalation of fumes of zinc and copper causing fever, body aches and chills for 1–2 days.

- Pneumonic anthrax is caused by inhalation of wool dust containing the spores.
- Benign pneumoconiosis which causes X-ray opacities (nodulation) without symptoms or disability is caused by inhalation of iron, barium and tin dust.
- Byssinosis is caused by prolonged exposure (7–10 years) to cotton dust in the textile industry especially in the ginning, bale opening and carding. It is manifested by chest tightness on the first day following a weekend. Initially, the patient is free of symptoms for the rest of the week. Chronic bronchitis, emphysema and disability are common complications.
- Pneumoconiosis is disabling pulmonary fibrosis that results from the inhalation of various types of inorganic dust, such as silica, asbestos, coal, talc and china clay, e.g. silicosis and asbestosis:

Silicosis: silicosis results from the inhalation of respirable particles of free crystalline silica (SiO_2). Exposure occurs in mining and quarrying operations, stone cutting and shaping, foundry operations, glass and ceramics manufacture, sandblasting and manufacture of abrasive soaps. It takes many years to develop the disease (7–10 years, sometimes less) and this depends on the concentration of the dust at the workplace, its silica content, the particle size and on individual susceptibility. The dust particles settle in the lungs and cause small nodules of fibrosis that progressively become more numerous, enlarge and coalesce causing fibrosis and progressive loss of lung function and disability. There may be coughing and expectoration. In the early stages there may be signs detectable by X-ray but later on the worker complains of increasing dyspnoea on exertion. Complications include pulmonary tuberculosis and cardiac or respiratory failure. The disease can be detected even before the symptoms appear by X-ray examination which shows numerous bilateral nodular shadows of different sizes or large masses of fibrosis.

Asbestosis: asbestosis is caused by inhalation of asbestos fibres. It is a hydrated magnesium silicate which is resistant to heat and many chemicals. In addition to mining and extraction, exposure to asbestos occurs in its use for insulation, in the making of asbestos cloth, in the manufacture of asbestos cement pipes and other products, vinyl floor tiles and in brake and cloth lining. Asbestos fibres, when inhaled, will cause diffuse interstitial fibrosis of the lungs, pleural thickening and calcification. Bronchogenic carcinoma or pleural and peritoneal mesothelioma are known effects. The early symptoms include progressive dyspnoea on exertion, cough, expectoration, chest pain, cyanosis and clubbing of the fingers. The disease takes about seven years to develop and depends upon the dust concentration at the workplace. Early detection depends on symptoms and signs and the X-ray picture. Smoking increases the risk of developing lung cancer several fold.

Dust control measures include:

- substitution of harmful dust with a harmless one
- automation and mechanization of dusty processes
- segregation of dusty jobs
- enclosure of dusty operations

- ventilation of general and local exhaust fumes
- housekeeping and general cleanliness
- the use of water in dust suppression
- for toxic dust: personal cleanliness, washing facilities, changing work clothes before going home, washing of work clothes, provision of separate areas for eating, drinking and smoking
- health education
- pre-placement medical examination
- personal protective equipment.

Pesticides

Pesticides are a group of chemicals used to destroy various kinds of pests including insects, rodents, weeds, snails, fungi, etc. The degree of toxicity of different pesticides varies greatly from deadly poisons to slightly harmful pesticides. Exposure to pesticides occurs in industries where the pesticides are manufactured and formulated, and during their application in agriculture or in public health. Pesticides are also used at home.

They are classified into several groups, according to their chemical composition. The most frequently used nowadays are organophosphates, carbamates and thiocarbamates, pyrethroids and organochlorine pesticides. Other groups include lead arsenate, organic mercury, thallium compounds, coumarin, bromomethane, cresols, phenols, nicotine, zinc phosphide, etc.

Pesticides are absorbed through the lungs, the gastrointestinal tract and sometimes through the intact skin and eyes (organophosphates).

(a) Organochlorine

Examples are DDT, aldrin, dieldrin, toxafene and gammaxane. They are slightly to moderately toxic, and are not biodegradable in the environment or in the human body. They accumulate in the environment and for this reason have been banned in many countries.

Acute exposure causes irritability of the central nervous system. Symptoms appear after 30 minutes to several hours (usually not more than 12 hours). They include headache, dizziness, nausea, abdominal pain, irritability, convulsions, coma, pyrexia, tachycardia, shallow respiration and death.

If the patient survives, convulsions stop within 24 hours but weakness, headaches and anorexia may continue for two weeks or more. Chronic exposure may cause gastrointestinal, liver, kidney or nervous affection.

First aid treatment:

- Remove contaminated clothing.
- Wash skin with soap and water but do not rub the skin.

- Induce vomiting, stomach wash and saline cathartic.
- Administer sedative for convulsions.
- Administer cardio-respiratory stimulants.

(b) Organophosphates

These include parathion, methyl parathion, malathion and tetraethyl pyrophosphate. Organophosphates include some extremely toxic and some slightly toxic compounds. They do not accumulate in the environment or in the human body. They are biodegradable within a few weeks.

Organophosphates cause the inhibition of the choline-esterase enzyme resulting in accumulation of acetyl choline in the body. Symptoms and signs include dyspnoea, sweating, nausea, abdominal colic, diarrhoea, constriction of the pupils, muscle twitches, irritability, anxiety, headaches, ataxia, convulsions, respiratory and circulatory failure, coma and death. In severe cases symptoms appear within minutes and in slight cases after hours but never exceeding 24 hours. Death may occur within hours in severe cases. If recovery occurs it takes a few weeks for the patient to return to normal. Blood examination reveals reduction of choline-esterase activity; the test is used in periodic medical examinations.

First aid treatment:

- Take patient to hospital.
- Remove contaminated clothing.
- Wash skin with water without rubbing (if available, a solution of 5% ammonia or 2% chloramine is more effective than water). However, if eyes are contaminated they must be washed with water.
- If the pesticide has been swallowed, first give the patient water to drink and then induce vomiting by putting your finger down the patient's throat.
- Administer atropine (the antidote) intravenously.
- Administer artificial respiration if required.
- Administer cardio-respiratory stimulants.
- Later, treat the patient with oximes.

(c) Carbamates and thiocarbamates

These are moderately toxic (carbaryl) and cause toxicity through the same mechanism as organophosphates except that inhibition of choline-esterase enzyme is temporary and recovers spontaneously within 48 hours if death does not occur.

(d) Pyrethroids

These are synthetic pesticides of low toxicity used in homes. Toxic symptoms take the form of sensitivity reactions.

Safe handling of pesticides

- Pesticides are licensed for use by the government following careful consideration of their toxicity to humans.
- Extremely toxic substances should not be handled freely by the public.
- Extra care should be taken during transportation of chemicals to ensure that containers are not crushed nor their contents spilt. If any spillage occurs, it should be reported and decontamination procedures carried out.
- All pesticide containers should be properly labelled in the local language.
- Storage sites should be properly cleaned and ventilated and should not be used by unauthorized personnel.
- Before using such chemicals application, workers should be well trained and have received health education.
- Public health measures should be taken to avoid contamination of water bodies and residential areas by chemicals.
- Crops should not be harvested before the time necessary for pesticides to biodegrade.
- Empty containers and pesticide waste should be properly disposed of.
- Workers should practise good personal hygiene.
- First aid treatment and antidotes should be available.
- Pre-placement and periodic medical examinations should be undertaken.
- All concerned, including the public, should receive health education regarding pesticides.
- Personal protective equipment should be supplied to workers.
- Engineering control measures should be in place within the chemical industry.

3.6 Biological hazards

Occupational infections

Human diseases caused by work-associated exposure to microbial agents, e.g. bacteria, viruses, rickettsia, fungi and parasites (helminths, protozoa), are called occupational infections. An infection is described as occupational when some aspect of the work involves contact with a biologically active organism.

Exposure occurs among health care workers in fever hospitals, laboratories and general hospitals; among veterinarians and agricultural workers in animal husbandry and dairy farms and pet shops; and among sewerage workers, wool sorters and workers in the leather industry.

(Occupational) pulmonary tuberculosis

Health care workers in tuberculosis treatment centres, in laboratories and in veterinary clinics are particularly affected. The disease is caused by *Mycobacterium tuberculosis* (Koch's bacillus) and is transmitted occupationally by droplet infection, contact with infected material from humans (sputum) or animals. The organism can survive in dust and away from direct sunlight for many days and enters the body through the respiratory tract or abraded skin where it causes a skin ulcer.

The disease usually affects the lungs but can also affect the gastrointestinal tract, bones, kidneys, meninges, pleura and peritoneum. Pulmonary tuberculosis is manifested by coughing, expectoration, haemoptysis, loss of weight, loss of appetite, night sweats and night fever. It can be diagnosed by chest X-ray and bacteriological examination of the sputum.

Workers should undergo a pre-placement examination and be tested with tuberculin and vaccinated with BCG if the tuberculin test is negative. Pre-placement and periodic X-rays should be taken. Health education is important and proper disposal of infected material should be observed.

Brucellosis

Brucellosis is caused by an organism which can infect cattle, sheep and pigs. The disease causes recurrent abortion in animals and is present in the placenta, in animal secretions, in milk and in urine. Exposed workers are veterinarians, workers in agriculture and animal husbandry, shepherds and laboratory and slaughterhouse workers. Most occupational cases occur through contact with infected animals or their secretions and products. The incubation period is 2–4 weeks.

The acute stage (undulant fever) extends for 2–4 weeks with fever, enlarged spleen and lymph nodes. In the subacute phase the organism localizes in joints, intestines, reproductive organs, pleura or meninges. In the chronic phase the localized disease continues with occasional fever or the only symptom may be general weakness. During this stage the disease is difficult to diagnose. Therefore, periodic medical examination of all exposed workers should be carried out using serological tests.

Control of the disease in humans depends on control in animals. Workers should wear protective clothing and observe proper cooking of animal products and boiling of milk since the disease can also be transmitted through food.

Anthrax

Anthrax is essentially an animal disease. Exposed workers are those in agriculture and animal husbandry, slaughter houses, tanneries and those working in the manufacture of goods from wool, hair, bones and leather. The disease affects cattle, sheep, horses and pigs and when the animal dies the anthrax bacillus forms spores which are extremely resistant and can survive for years.

Infection can occur through the skin, the lungs or the intestine. Infection through the skin causes a "malignant pustule". It starts with erythema 1–8 days after infection which leads to a papule then pustule with surrounding swelling and local lymph node enlargement. Infection through the lung occurs in wool stores causing

severe fatal pneumonia. Infection through the intestines causes septicaemia.

Animal products intended for use in industry should be carefully examined and disinfected.

Viral hepatitis B and C

Health care workers who are likely to come into contact with the blood and body fluids of infected persons are at great risk of infection. An acute onset of hepatitis is the exception; more often there are vague general symptoms or none at all and the infection is discovered on routine serological examination.

The disease may pass into chronic active hepatitis: liver cirrhosis, hepatic failure and liver carcinoma.

Because of the exposure to patients' body fluids via contaminated glassware and other contaminated equipment, such as needles, which may provide an opportunity for contact with mucous membranes or parenteral innoculation, strict "infection control" procedures should be developed for situations where there is potential risk, such as phlebotomy, dentistry and haemodialysis.

Workers at increased risk of hepatitis B infection should receive hepatitis B immunization.

Acquired immunodeficiency syndrome (AIDS)

Transmission of the acquired immunodeficiency syndrome (AIDS) agent, the human immunodeficiency virus (HIV), occurs only through sexual contact, perinatally from an infected mother and through contaminated blood or blood products. Seroconversion after a needle-stick injury is estimated to be less than 1%, which is much lower than the risk (6%–30%) of acquiring hepatitis B after a needle-stick injury.

The virus is **not** transmitted through casual, non-intimate workplace contact or social encounters, such as eating in restaurants or using public transportation or bathroom facilities.

The following groups are at potential risk of contact with HIV-infected body fluids:

- blood bank technologists
- dialysis technicians
- emergency room personnel
- morticians
- dentists
- medical technicians
- surgeons
- laboratory workers
- prostitutes.

For occupational health professionals, employees trained in first aid and public safety personnel who may provide medical services to HIV-infected individuals, reasonable steps should be taken to avoid skin, parenteral or mucous membrane contact with potentially infected blood, plasma or secretions.

- Hands or skin should be washed immediately and carefully if blood contact occurs.
- Mucous membranes (including the eyes and mouth) should be protected by eye glasses or masks during procedures that could generate splashes or aerosols of infected blood or secretions (suctioning, endoscopy).
- Contaminated surfaces should be disinfected using 5% sodium hypochlorite.

Workers in the personal service sector, who work with needles or other instruments that can penetrate intact skin, such as tattooists and hairdressers, should follow precautions indicated for health care workers and practise aseptic techniques and sterilization of instruments. All personal service workers should be educated concerning transmission of blood-borne infections, including AIDS and hepatitis B.

3.7 Other exposures and their health effects

Occupational dermatoses

Occupational dermatoses are the most common occupational diseases and are almost always preventable by a combination of environmental, personal and medical measures.

The skin can be affected by many factors:

- repeated mechanical irritation may cause callosities and thickening of the skin
- various kinds of radiation (see Module 1, 3.2, Potential health hazards)
- tuberculosis and anthrax
- chemicals can cause irritation or sensitization.

Types of occupational dermatosis:

- acute contact eczema due to irritation or sensitization
- chronic contact eczema due to irritation or sensitization
- chloracne (lubricating and cutting oils, tar and chlorinated naphthalenes)
- photosensitization (chemicals, drugs and plants)
- hypopigmentation and hyperpigmentation (dyes, heavy metals and chlorinated hydrocarbons)
- keratoses (ionizing radiation, ultraviolet radiation)
- benign tumours and epitheliomas (UV, ionizing radiation, tar, soot, arsenic)
- ulcers (trauma, burns).

Occupational cancer

The cause of cancer is still not completely understood. It has been observed however, through epidemiological studies and statistical data that cancer of certain organs has been associated with certain exposures.

Occupational cancer is no different from ordinary cancer as far as signs and symptoms or histopathology are concerned. A positive history of exposure to a carcinogenic agent can be obtained in occupational cancer. Examples of some carcinogenic agents and the organs affected are given below.

Carcinogenic agent	***Organ affected***
Arsenic	Skin and lung
Chromium compounds, hexavalents	Lung
Nickel	Lung and nasal sinus
Polycyclic aromatic hydrocarbons	Skin
Coal tars	Skin, scrotum, lung, bladder
Benzol	Blood (leukaemia)
B-naphthalamine	Bladder
Ionizing radiation	Skin, bone, lung, blood (leukaemia)
Asbestos	Lung, pleura, peritoneum

Reproductive effects

Occupational exposure to certain chemicals or physical factors (like ionizing radiation) has been found to have certain effects on reproductive functions:

- dysfunction in males (sterility or defective spermatozoa) and females (anovulation, implantation defects in the uterus)
- increased incidence of miscarriage, stillbirth and neonatal death
- induction of structural and functional defects in newborn babies
- induction of defects during the early postnatal development stage.

Exposure of either parent may lead to reproductive defects.

Chemicals which have been suspected of reproductive effects include:

- alcohols
- anaesthetic gases
- cadmium
- carbon disulfide
- lead
- manganese
- polyvinyl chloride.

Occupational asthma

Asthmatic patients suffer from attacks of shortness of breath. Although bronchial asthma can be caused by a large number of substances or combinations of substances outside the workplace, many occupational exposures can be associated

with the occurrence of asthma. Although in many cases it is difficult to evaluate how much of the problem is caused by workplace exposure, in certain instances it is obvious that asthmatic attacks are caused by work exposure only and not by factors outside work.

Examples of substances that may cause occupational asthma:

- Plant origin:
  - wood dust
  - flour and grain dust
  - fungal spores
  - formaldehyde
  - gum arabic

- Animal origin:
  - wool
  - hair
  - feathers

- Other substances:
  - antibiotics (penicillin)
  - toluene diisocyanate
  - platinum salts.

4. WORK-RELATED DISEASES

4.1 Characteristics of work-related diseases

This category has certain characteristics which were identified and stated by a WHO Expert Committee as follows:

> "Multifactorial diseases", which may frequently be work-related, also occur among the general population, and working conditions and exposures need not be risk factors in each case of any one disease. However, when such diseases affect the worker, they may be work-related in a number of ways: they may be partially caused by adverse working conditions; they may be aggravated, accelerated or exacerbated by workplace exposures; and they may impair working capacity. It is important to remember that personal characteristics, other environmental and sociocultural factors usually play a role as risk factors for these diseases....
>
> Multifactorial "work-related" diseases are often more common than occupational diseases and therefore deserve adequate attention by the health service infrastructure, which incorporates the occupational health services.[2]

The work-related diseases which deserve particular attention are:

- behavioural and psychosomatic disorders

---

[2] *Identification and control of work-related diseases.* Report of a WHO Expert Committee (WHO Technical Report Series No. 714), Geneva, World Health Organization, 1985.

- hypertension
- coronary heart disease
- peptic ulcers
- chronic nonspecific respiratory disease
- locomotor disorders.

4.2 Behavioural and psychosomatic disorders

Both home and work environments can be a major source of adverse psychosocial factors. Individuals differ widely in their responses.

Risk factors for behavioural and psychosomatic disorders

(a) Environmental psychosocial risk factors

- work overload and underload
- boredom and lack of control over work situation
- shift work
- migration (migrant workers)
- organizational structure at the work establishment and the role of the individual in the organization; role ambiguity and role conflict
- opportunity for career development and promotion
- physical insecurity (fires, explosions) and responsibility for other people's safety
- job design and degree of interest
- low wages
- job turnover
- early or involuntary retirement
- unemployment.

(b) Physical stressors

- thermal environment
- noise
- vibration
- radiation
- poor lighting.

(c) Environmental chemical stressors

These can increase the risk of psychosomatic illness. Some chemical hazards however, have specific effects on the central nervous system, e.g. carbon monoxide, carbon disulfide, alcohols and some other solvents.

(d) Social support system

This improves the ability of an individual to adapt to environmental psychosocial stress. Support can be from the family, the work community or the community outside of work.

(e) Individual psychosocial factors

- inter-individual relationship at work
- personality type
- individual susceptibility
- age
- sex.

Behavioural and psychosocial reactions to stress

- overeating leading to obesity
- smoking
- alcohol and drug abuse and drug addiction, any of which can be a risk factor for psychosomatic illness
- fatigue
- anxiety
- depression
- hostility and aggression
- neurosis causing a range of mental and emotional disorders
- mental disorders and psychiatric disorders
- mass psychogenic illness (mass hysteria)
- psychosomatic disease: headache, backache, muscle cramps, disturbed sleep, peptic ulcer, diabetes mellitus, cardiovascular disorders etc.

4.3 Hypertension

In over 90% of patients with hypertension, the disease is called "essential hypertension" and no cause can be identified. Genetic predisposition is an important risk factor. Exposure to lead, cadmium and noise is a risk factor in developing hypertension and it has also been suggested that psychosocial stress is a factor in the development of hypertension. Other risk factors in the development of hypertension include dietary habits (excess salt and fats), obesity and physical inactivity.

4.4 Coronary heart disease (CHD)

Narrowing of the coronary arteries causes inadequate blood supply to the heart muscle causing "angina pectoris" or recurrent brief attacks of chest pain often associated with exercise. Occlusion of any artery causes myocardial infarction or necrosis of part of the heart muscle which may cause death within a short time or later on due to complications.

The incidence of the disease is increasing and more and more younger people are being affected. It is more common in men than women below 45 years of age, but in older age the two sexes may be equal.

The risk of coronary heart disease is associated with hypertension, high dietary fat intake, high serum cholesterol and being overweight. In addition there is a significant familial tendency. A coronary-prone personality has been described as the aggressive, competitive person who takes on too many jobs, fights deadlines and is obsessed by lack of adequate time to finish his work. Overload at work has also been associated with coronary heart disease.

Psychosocial stress increases serum cholesterol, causes hypertension and enhances clot formation. Cigarette smoking is another risk factor for CHD. Other occupational factors related to CHD are sedentary work, exposure to carbon disulfide, carbon monoxide and nitrates and chronic exposure to noise, heat and cold. Solvents such as benzene, trichlorethylene, chloroform, ethyl chloride and fluorocarbon compounds directly affect the myocardial tissue. Lead and mercury cause CHD, secondary to hypertension, and cobalt, arsenic and antimony produce myocardial damage.

4.5 Peptic ulcer

Several risk factors have been associated with the development of gastric and duodenal ulcers. These include heredity, certain medicines (analgesics and non-steroidal anti-inflammatory drugs), cigarette smoking, medical illness, surgical procedures, type of personality, local infection (*Helicobacter pylori*) and occupation.

Occupational factors associated with the risk of developing peptic ulcers include jobs with a high degree of responsibility and irregular shift work; the higher the work stress the higher the ulcer rate. Also peptic ulcers are related to inhaled irritant gases which dissolve in sputum and are ingested.

4.6 Chronic nonspecific respiratory diseases (CNRD)

CNRD is a general term used to describe a group of diseases in which there is chronic cough and sputum production and/or shortness of breath at rest and/or during exercise. These conditions include chronic bronchitis, emphysema, bronchial asthma and asthmatic bronchitis. All these diseases may be acutely or chronically exacerbated by infection. CNRD are diseases of multiple etiology and represent a classic example of disorders that may be occupational in origin, work-related or related to the social phenomena of urbanization and industrialization.

When the risk of these disorders is strongly related to specific occupational exposure such as non-fibrogenic dusts (e.g. cotton, rice and flax) or irritants, they

may easily be thought of as occupational diseases. It is well known, however, that other factors, such as smoking, climatic conditions, community air pollution, atopy, familial genetic factors, individual susceptibility, bronchial hyper-reactivity, childhood respiratory infections, repeated respiratory infections in adult life and socioeconomic status, can play a major role. In any individual case, it is difficult to ascertain how much synergism has occurred between any combination of two or more. It is generally believed however, that in smokers who are exposed to community or workplace air pollution, smoking plays a more important role in the causation of CNRD than does air pollution.

In dusty occupations where dust is known to cause specific pulmonary diseases (silicosis, asbestosis, coal workers' pneumoconiosis, byssinosis, etc.), dust concentrations lower and durations shorter than those which cause the specific disease may be sufficient to contribute to the causation of CNRD.

Examples of occupations where work-related CNRD may occur are those where dust (organic or inorganic), irritant gases or aerosols are present. These pollutants may contribute to the causation of CNRD by causing irritation of the respiratory mucous membrane or through allergic mechanisms. These occupations include the chemical industry, mining, foundries, textile mills, silos, cement factories, the glass industry, the fertilizer industry, steel mills, smelters and a multitude of other occupations.

4.7 Locomotor disorders

Two examples of locomotor disorder will be given for which evidence of work relatedness is available: low back pain syndrome and shoulder–neck pain syndrome.

Low back pain

Low back pain is a symptom of common occurrence in the general population, affects males and females at all ages, but is more common between the ages of 25 and 64 years. It is said to affect over half the working population at some time during their active working life and it is estimated that 2%–5% of industrial workers experience low back pain each year.

Pain in the lumbosacral area can result from inflammatory, degenerative, traumatic, neoplastic or other disorders. In some instances it is claimed to be psychogenic in origin. The most common type of occupational low back pain is nonspecific, of indeterminate pathology and often associated with posture, lifting of heavy objects and injurious (twisting) movements of occupational or non-occupational origin.

The risk factors for low back pain include congenital back defects, weak musculature, rheumatic affection and degenerative conditions of the spine and intervertebral discs. Certain occupations carry a higher risk of developing low back pain. These include heavy manual work, mining, docking, material handling, jobs requiring awkward postures and postures that have to be maintained for prolonged periods or involve frequent bending, twisting or whole body vibration, nursing and policing. These occupations require proper selection, physical training, proper placement and adoption of safe criteria for load lifting.

Shoulder–neck pain

A variety of diseases may result in shoulder and neck pain: examples are inflammatory reactions in the synovial membrane and bursa system and degenerative disorders in the cartilage, ligaments and tendons. In addition, muscular, vascular and neuromuscular disorder may result in shoulder pain and pain may be referred from the chest.

Disorders associated with general muscle weakness and general malaise, such as infections, may also result in an increased susceptibility to shoulder and neck complaints from loads on the shoulder which a worker can normally tolerate. From the occupational health standpoint, individual predisposing factors such as age, difficulties in organizing the work task and inflammatory rheumatic predisposition play a role.

It has been found that working with the hands above shoulder height is more frequent in workers with both acute and chronic shoulder and neck pain. However, increased work loads on shoulder and neck muscles can also be produced without lifting the arms above the shoulders.

Further proof of the work-relatedness of shoulder and neck pain is presented by the fact that application of ergonomic principles to improve methods of work reduces the pain.

5. TASKS FOR TRAINEES

1. Carry out a workplace survey and make observations.

- ♦ Look for any potential and actual hazards (physical, chemical, mechanical, biological and psychological)
- ♦ Consider the availability or the need for control measures
- ♦ Look for any early signs of occupational disease and work-related disease in workers.

2. Join and work with members of the occupational health team; report your observations and consult with them regarding control measures, the need for environmental and biological monitoring and the management of certain occupational health problems (where applicable).

3. Use your skills in doing simple tests; collect biological samples for analysis and advise on need for further investigations (as applicable).

4. Educate workers on the use and maintenance of personal protective equipment.

5. Discuss with workers matters relating to nutrition and sanitation and advise them on healthy eating habits, good sanitary measures and personal hygiene.

6. Advise management regarding the need for control measures and the need to investigate some occupational health problems that require consultation with other members of the occupational health team.

7. Advise management on the implementation of occupational health legislation in the workplace.

8. Advise workers on the need to observe the control measures instituted for a healthy and safe workplace.

9. Keep and update records of all occupational health activities undertaken by you (reports on plant surveys, reports on environmental and biological monitoring and reports on health trends at the workplace).

MODULE 3

Early detection of occupational diseases

1. OBJECTIVES

- Understand the importance of the early detection of occupational diseases
- Choose the most appropriate diagnostic means for early detection of occupational diseases
- Know how to participate effectively in carrying out periodic medical examinations for workers.

2. INTRODUCTION AND BASIC CONCEPTS

Occupational diseases are unique in the sense that the hazards that cause them are known even before exposure of the workers takes place. This fact characterizes occupational diseases as being entirely preventable; exposure can be controlled or prevented. The ideal situation of complete prevention of occupational diseases by controlling exposures however, does not occur in practice, and occupational diseases continue to occur.

To minimize the damage caused by occupational diseases, the best alternative is early detection of pathological changes at a stage when they are reversible. Certain occupational exposures cause early clinical, functional, biochemical, physiological or morphological changes which, when detected early enough, are reversible. There are many clinical, laboratory or other tests that have been developed to detect these early changes, each exposure having its specific test.

Unfortunately, there are other occupational diseases which cannot be detected at a reversible stage. These include acute reactions to irritant gases, e.g. ammonia, asphyxiants, e.g. CO and hydrocyanic acid, and corrosive materials, e.g. acids and alkalis; collagenous pneumoconiosis, e.g. silicosis and asbestosis; occupational cancer, and many other conditions. Acute conditions, caused mostly by occupational accidents, are amenable to treatment and will not be discussed.

The progress of pneumoconiosis can be slowed down considerably if exposure is discontinued. Also, it is well known that detection of occupational cancer at an early stage improves prognosis. Therefore, regardless of the reversibility of the pathological changes caused by occupational exposure, early detection of occupational disease is desirable.

Many indices used in early detection of occupational diseases have very wide ranges of normal variability. Results of such tests can move between the two ends of the normal range in a given individual without being recognized as abnormal; an individual with a predicted vital capacity of ± 4 l can deteriorate from 5 l to 3 l

without being recognized as abnormal unless the pre-employment level is known. Therefore, a pre-placement record of variables, as well as periodic examinations, is necessary for the early detection of disease.

The terms "early detection" and "periodic examination" will be used in this text to denote examinations carried out to detect early occupational disease whether this early disease is reversible (curable) or not.

Considering the very large numbers of workers that have to be examined, periodic examinations do not have to be comprehensive check-ups. Examinations usually start with simple screening tests and positive cases then undergo comprehensive examinations to prove or disprove the presence of occupational diseases. Screening tests have to be simple, sensitive, specific, easy, inexpensive and non-invasive. Screening tests include tests to detect:

- the presence of a toxic material in a certain biological sample, as an index of exposure to that material the presence of which may have been proved by environmental monitoring, e.g. monitoring lead in blood
- the presence of metabolites of a toxic substance in a biological sample, e.g. monitoring organic sulfates in urine in phenol exposure.

  In both cases biological threshold limit values are recommended concentrations of the substance or its metabolites in the biological fluids or tissues that should not be exceeded if the disease is to be prevented. Biological threshold limit values are available for many toxic exposures.

- changes in organ functions as a result of exposure to substances where the organs are targets for the toxic action, e.g. kidney functions, liver functions and pulmonary functions;
- morphological changes in blood elements that may indicate toxic action on the haemopoietic system;
- irreversible tissue changes, e.g. cataract due to exposure to infrared radiation, ionizing radiation or X-ray examination to detect silicosis and asbestosis;
- psychomotor and higher central nervous system functions, e.g. tests have been used to evaluate exposure to substances known to affect nervous functions, e.g. manganese, mercury and carbon disulfide. As screening tests their specificity is rather low and they are too elaborate to be used for mass screening.

The regularity of examinations varies with the type of exposure. Diseases with conditions which progress rapidly, e.g. changes in choline-esterase activity in those working with pesticides should be monitored at monthly intervals or even more frequently.

Affection of the blood picture due to ionizing radiation can be monitored at periods ranging from 1 to 6 months depending on the exposure dose. For diseases that start to appear after many years, e.g. noise-induced hearing loss and silicosis, periodic examination can start after many years of exposure (3–5 years) and since progress is slow, examination can be repeated after periods from 1–2 years. Cancer appears after even longer periods.

3. EARLY DETECTION OF OCCUPATIONAL DISEASES CAUSED BY PHYSICAL FACTORS

3.1 Heat

The severity of health effects from heat increases with the temperature, humidity and duration of exposure. In order of increasing severity the health effects are:

- lassitude, irritability, discomfort
- lowered work performance and lack of concentration
- heat rash
- heat exhaustion
- heat stroke.

3.2 Noise

Noise-induced hearing loss can be detected by audiometry. Early loss affects high tones (3000–6000 Hz) long before hearing of every day speech is affected. Noise-induced hearing loss is permanent.

3.3 Vibration

Vibrations cause vascular disorders of the arms and bony changes in the small bones of the wrist. Vascular changes are difficult to detect, tests are complicated and non-specific, but bony changes can be detected by X-ray examination of the wrist. The most common finding is rarefaction of the lunate bone.

3.4 Atmospheric pressure

Exposure to increased atmospheric pressure (under water) leads to aseptic bone necrosis around the knee, hip and shoulder which can be detected by X-ray examination.

3.5 Infra-red radiation

Exposure to infra-red radiation causes cataract, an opacity of the eye lens which affects the posterior part of the lens. Cataract causes progressive failure of vision and can be detected by slit lamp examination. The affected lens has to be removed.

3.6 Ionizing radiation

Exposure to ionizing radiation also causes cataracts. Since the blood forming organs are among the most sensitive to ionizing radiations, the blood should be examined periodically. The leucocytic count is indicative of affection and is more useful if the pre-employment results are available. Keratoses of the skin are pre-cancerous conditions.

4. EARLY DETECTION OF OCCUPATIONAL DISEASES CAUSED BY BIOLOGICAL AGENTS

4.1 Pulmonary tuberculosis

This can be detected by X-ray examination of the chest. Mass miniature radiography is a useful tool. A Mantoux test can be strongly positive and Gram-negative, acid-fast bacilli may be detectable on sputum culture.

4.2 Chronic brucellosis

Chronic brucellosis is difficult to diagnose clinically but can be detected by serological examination (tube agglutination test).

4.3 Viral hepatitis B and C

These can be detected by serological examination and determination of hepatitis markers.

5. EARLY DETECTION OF OCCUPATIONAL DISEASES CAUSED BY CHEMICALS

5.1 Metals

Lead

(a) Essentials of diagnosis

Inorganic-acute effects

- abdominal pain (colic)
- encephalopathy
- haemolysis
- acute renal failure

Inorganic-chronic effects

- fatigue and asthenia
- arthralgia and myalgias
- anaemia
- peripheral neuropathy (motor)
- neurobehavioural disturbances and chronic encephalopathy
- gout and gouty nephropathy
- chronic renal failure

Alkyl lead compounds

- fatigue and lassitude
- headaches
- nausea and vomiting
- neuropsychiatric complaints (memory loss, difficulty in concentrating)
- delirium
- seizures
- coma

(b) Early detection of excessive exposure to lead can be determined by:

Determination of lead concentration in blood and urine

An average normal value of lead in blood of 30 µg/dl is not unusual in cities with heavy traffic. Patients with lead poisoning have values of 80 µg/dl or higher.

Indices of effect

- delta-aminolevulinate dehydratase in blood
- delta-aminolevulinic acid in urine
- coproporphyrin in urine
- zinc protoporphyrin in the erythrocytes

Mercury

(a) Essentials of diagnosis

Inorganic mercury

- acute respiratory distress
- gingivitis
- tremor
- erythism (shyness, emotional lability)
- proteinuria, renal failure

Organic mercury (alkyl mercury compounds)

- mental disturbances
- ataxia, spasticity
- paraesthesias
- visual and auditory disturbances

(b) Early detection of exposure to mercury (inorganic and alkyl organic mercury)

This is carried out by the measurement of mercury in urine. The normal value in non-exposed individuals is less than 20 µg/l.

Organic alkyl compounds (methyl mercury) can be estimated in plasma and erythrocytes.

Manganese

(a) Essentials of diagnosis

Acute effects

- fever
- chills
- dyspnoea (metal fume fever)

Chronic effects

- Parkinson-like syndrome
- behavioural syndrome
- pneumonia

(b) Estimation

The estimation of manganese in biological fluids does not help in early diagnosis. Detection of the disease in the clinical stage depends on the neuropsychiatric manifestations.

Arsenic

(a) Essentials of diagnosis

Acute effects

- nausea
- vomiting
- diarrhoea
- intravascular haemolysis
- jaundice
- oliguria (arsine)
- cardiovascular collapse

Chronic effects

- hyperkeratosis and hyperpigmentation (melanosis)
- peripheral neuropathy

- anaemia
- cardiac and peripheral vascular disease

(b) Chronic exposure

This can be evaluated by measurement of arsenic in urine. In non-exposed normal individuals it does not exceed 30 µg/l. Seafood raises the concentration of arsenic in urine. Estimation of arsenic in hair and nails can give a good index of chronic exposure, however external contamination should be avoided. Hair and nails should be washed thoroughly.

5.2 Organic solvents and biological tests used for detection of exposure

Organic solvent and its health effects	*Methods of evaluation of exposure*
Benzene (benzol)	
Acute exposure Anaesthesia: dizziness, headache, nausea, vomiting, sleepiness, fatigue, slurred speech, disequilibrium, disorientation, depression, loss of consciousness Respiratory tract irritation: sore nose and throat, cough	Periodic red and white cell counts of questionable value but may detect early haemopoietic effects Benzene in blood (specific, sensitive, the best approach available at present) Trans trans-muconic acid in urine (reasonably specific, sensitive) Phenylmercapturic acid in urine (specific, sensitive, sophisticated methodology)
Chronic exposure Bone marrow depression with a delayed effect, many years in some cases Early symptoms and signs are vague, but later tiredness and spontaneous bleeding may occur as anaemia, pancytopenia and/or thrombocytopenia become more severe Aplastic anaemia, acute myeloblastic leukaemia and acute erythroleukaemia are the most feared effects of chronic exposure	Benzene in urine (specific, sensitive, limited experience) Phenol in urine (non-specific, insensitive) Benzene in exhaled breath (specific, sensitive, limited practicability)
Toluene (methyl benzene)	
Toluene exposure is rarely pure and exposure frequently includes benzene with or without xylene	Hippuric acid in urine collected at the end of the work shift. (Note: hippuric acid is not a metabolite specific to toluene; it can be produced from dietary sources, such as food preserved with benzoic acid).
Acute exposure Narcotic Conjunctival irritation and ulceration Cardiac arrhythmia (has caused deaths in "sniffers")	
Chronic exposure Liver, kidney and bone marrow (probably due to benzene as contaminant)	

Xylene

Acute exposure	Methyl hippuric acid in urine
Mucous membrane irritation	
Narcotic	
Chronic exposure	
Aplastic anaemia has been postulated but may be due to benzene contamination (with toluene)	

Aminobenzene (aniline)

Acute exposure	Methaemoglobin in blood.
Mild skin irritant	Para-aminophenol in urine
Moderate exposure may only cause some cyanosis	
Severe poisoning results in anoxia and death, which may be delayed for a few hours after exposure	

Carbon tetrachloride

Acute exposure	CCl_4 in expired air
Nausea, vomiting, drowsiness, dizziness	Blood concentration is of limited value
Chronic exposure	
Dry, scaly dermatitis	
Centrilobular necrosis with or without fatty degeneration of the liver	
Acute oliguric renal failure	

Polychlorinated biphenyls

Acute exposure	PCBs in blood
Skin rash (chloracne)	
Eye irritation	
Nausea, vomiting	
Chronic exposure	
Weakness, weight loss, anorexia	
Skin rash (chloracne)	
Numbness and tingling of extremities	
Elevated serum triglycerides	
Elevated liver enzymes	

Methylene chloride (dichloromethane)

Acute exposure	Carboxyhaemoglobin levels in blood and carbon monoxide in exhaled air
Skin and mucous membrane irritant	Smoking affects biological monitoring results
Acute intoxication with stupor, numbness and tingling of limbs following inhalation	
Chronic exposure	
Dry, scaly dermatitis	
Can precipitate cardiac insufficiency due to increase in carboxyhaemoglobin	

Chloroform

Acute exposure	Chloroform in exhaled air and in blood
Skin irritant, potent anaesthetic	
Chronic exposure	
Liver enlargement and damage potentiated by alcohol abuse (causes hepatic tumours in rodents)	
Oliguric renal failure	
Chronic dry, scaly dermatitis	

Trichloroethane

Acute exposure
Mucous membrane and skin irritant
Narcotic
Capable of sensitizing the myocardium to adrenaline thereby causing arrhythmias

Chronic exposure
Dry, scaly dermatitis

Trichloroethane, trichloroethanol and trichloroacetic acid in expired air, blood and urine.

Trichloroethylene

Acute exposure
Powerful narcotic, action exacerbated by ethanol
Mild respiratory and skin irritant.

Chronic exposure
Periphera; neuropathy has been reported
Addictive

Expired air for trichloroethylene and trichloroacetic acid
Trichloroethanol and trichloroacetic acid in blood or urine

Tetrachloroethylene

Acute exposure
Powerful narcotic
Can cause mucous membrane and skin irritation as well as liver damage

Chronic exposure
CNS depression and liver damage
Rodent carcinogen

Tetrachloroethylene, trichloroethanol and trichloroacetic acid in blood, alveolar air and urine

Carbon disulfide (CS_2)

Acute exposure
Severe skin and mucous membrane irritant
Dizziness, headaches, psychosis, drowsiness

Chronic exposure
Four distinct syndromes:

Parkinson-like affection due to the corpus striatum and globus pallidus
Peripheral neuropathy affecting motor and sensory nerves as well as ocular nerves
Psychotic conditions (rarely seen nowadays, but lesser neuropsychiatric states are still described)
Cardiovascular disease, possibly due to increased blood cholesterol and B-lipoprotein leading to ischaemic heart disease and peripheral vascular damage. (Recent research suggests that part of this cardiovascular affect may be due to an acute myotoxic effect on cardiac muscle leading to fatal arrhythmias

The iodine azide reaction with urine at the end of the work day and at the beginning of the work day will detect organic sulfate metabolites of carbon disulfide, but the reaction is not specific for CS_2

5.3 Pesticides

Exposure to organophosphates can be evaluated by determining the degree of inhibition of choline-esterase activity in the blood. There are laboratory methods for evaluation of choline-esterase activity which are accurate and satisfactory. There are also many simpler field survey methods and kits that are not as accurate but are quite useful.

Since there are wide variations in the values of choline-esterase activity among individuals, it is important to compare individual figures with pre-exposure levels for the same individual, measured by the same method. Symptoms of poisoning with

organophosphates appear when choline-esterase activity have been reduced by 50%–60% of pre-exposure levels. Severe cases may show 75% reduction.

Measurement of choline-esterase activity is also the test for detection of poisoning or exposure to carbamate and thiocarbamate pesticides.

5.4 Pulmonary dust diseases

Early diagnosis of byssinosis is made using a special questionnaire which demonstrates the presence of chest tightness on the first day after the weekend leave, in early cases. X-ray examination in cases of byssinosis yields negative results and the demonstration of airway obstruction by pulmonary function testing is not specific.

In the case of exposure to fibrogenic dust, after a satisfactory occupational history has been elicited, a positive X-ray is the main tool for early diagnosis. This is applicable in the case of silicosis, asbestosis, talc pneumoconiosis and china clay pneumoconiosis. It should be noted, however, that once a positive X-ray is obtained, these diseases are irreversible.

In the case of extrinsic allergic alveolitis (bagassosis, farmers' lung), the diagnosis of acute, subacute and chronic cases can be confirmed by X-ray examination.

Serological examination may help.

6. TASKS FOR TRAINEES

1. Familiarize yourself with the techniques and technologies used in early detection of occupational diseases.
2. Observe how the pre-placement/periodic medical examinations are carried out and record your observations of the communication skills required in eliciting information from the worker.
3. Associate the results obtained during the periodic medical examination with the results of environmental monitoring of the workplace. Prepare a report on your observations.
4. Review the medical records at the workplace and make your observations regarding the history of signs and symptoms of occupational disease.
5. Acquaint yourself with the International Labour Organisation's (ILO) International Classification of Radiographs of Pneumoconioses.
6. Review the current available data on biological monitoring of occupational hazards.
7. Advise management on the need to carry out regular medical examinations on their workers.
8. Advise workers on the need to pass a medical examination on a regular basis.
9. Advise workers on the need to recognize the early signs and symptoms of occupational diseases.

MODULE 4

Occupational ergonomics

1. OBJECTIVES

- Understand the human–machine–environment relationship
- Be aware of ergonomics as a tool for healthier and safer working conditions
- Know how to take into account the workers' dimensions and the physical/psychosocial capabilities and limitations in order to avoid harmful working conditions
- Collect information in the work situation about both the workers and the nature of the work in order to offer correct and prioritized advice
- Create awareness as to why and how to improve the work situation and to give simple suggestions in order to design ergonomically efficient new work situations
- Communicate with management and workers about improvements in the work situation in order to benefit as much as possible.

2. INTRODUCTION AND BASIC CONCEPTS

Ergonomics is the study of the complex relationships between people, physical and psychological aspects of the work environment (e.g. facilities, equipment and tools), job demands and work methods. It is a field which integrates knowledge derived from the human sciences (in particular anatomy, physiology and psychology) to match jobs, systems, products and environments to the physical and mental abilities and limitations of workers. Ergonomics stresses fitting the job to the worker as compared to the more usual practice of obliging the worker to fit the job.

The aim of ergonomics is primarily to optimize, first and foremost, the comfort, as well as the health, safety and efficiency, of the worker. Applying ergonomic principles however, is not only beneficial to workers. The benefits to employers are equally significant and are both visible and measurable in terms of increased efficiency, higher productivity, reduction in work time lost due to illness or injury and decreased insurance costs.

A fundamental principle of ergonomics is that all work activities cause the worker to experience some level of physical and mental stress. As long as this stress is kept within reasonable limits, work performance should be satisfactory and the worker's health and well-being should be maintained.

If stress is excessive, however, undesirable outcomes may occur in the form of errors, accidents, injuries or decreases in physical or mental health. Ergonomically-related injuries and illnesses range from eye strain and headaches to musculoskeletal ailments such as chronic back, neck and shoulder pain, cumulative

trauma disorders (CTDs), repetitive strain injuries (RSIs) and repetitive motion injuries (RMIs)—three terms which are used interchangeably.

Preventing eyestrain, headaches and musculoskeletal disorders and obtaining optimal performance can be achieved when equipment, workstations, products and working methods are designed according to human capabilities and limitations, i.e. by applying principles of ergonomics.

The costs of ignoring these basic principles include:

- injuries and occupational diseases (including RSI, CTD and RMI)
- increased absenteeism
- higher medical and insurance costs
- increased probability of accidents and errors
- higher turnover of workers
- less production output
- lawsuits
- low-quality work
- less spare capacity to deal with emergencies.

The goal of an occupational ergonomics programme is to establish a safe work environment by designing facilities, furniture, machines, tools and job demands to be compatible with workers' attributes (such as size, strength, aerobic capacity and information processing capacity) and expectations. A successful ergonomics programme should simultaneously improve health and enhance productivity.

Examples

Prevention of accidents

- Designing a machine guard that will allow a worker to operate a piece of equipment with smooth, non-awkward, time-efficient motions. This minimizes any inconvenience introduced by the guard and decreases the likelihood that it will be bypassed or removed.
- Studying the biomechanics of the human walk to determine forces and torques acting at the interface between the floor and the sole of the shoe. This information can be used to improve the friction characteristics of floor surfaces and shoe soles to reduce the risk of a slip or fall.

Prevention of fatigue

- Designing a computer work station (equipment and furniture) so that an operator can use a video display unit (VDU) for an extended period of time without experiencing visual or postural fatigue.
- Evaluating the metabolic demands of a job performed in a hot, humid environment to recommend a work–rest regimen that will prevent heat stress.

Prevention of musculoskeletal disorders

- Evaluating lifting tasks to determine biomechanical stresses acting on the lower back and designing lifting tasks to ensure that these stresses will not cause back injuries.
- Evaluating highly repetitive manual assembly operations and developing alternative hand tools and work methods to reduce the risk of cumulative trauma disorders such as tendonitis, epicondylitis, tenosynovitis and carpal tunnel syndrome.

3. ERGONOMICS: A MULTIDISCIPLINARY SCIENCE

Ergonomics is a multidisciplinary science with four major areas:

- human factors engineering
- work physiology
- occupational biomechanics
- anthropometry.

3.1 Human factors engineering

Human factors engineering, sometimes called engineering psychology, is concerned with the information processing aspects of work.

Objectives of human factors engineering

Broadly, the objectives are to design procedures, equipment and the work environment to minimize the likelihood of an accident caused by human error.

- Basic operational objectives:
  - reduce errors
  - increase safety
  - improve system performance
- Objectives bearing on reliability, maintainability and availability (RMA) and integrated logistic support (ILS):
  - increase reliability
  - improve maintainability
  - reduce personnel requirements
  - reduce training requirements
- Objectives affecting users and operators:
  - improve the working environment
  - reduce fatigue and physical stress
  - increase human comfort
  - reduce boredom and monotony

  - increase ease of use
  - increase user acceptance

- Other objectives:
  - reduce loss of time and equipment
  - increase economy of production.

Common causes of work accidents caused by human error

(a) Failure to perceive or recognize a hazardous condition or situation

To react to a dangerous situation it is necessary to perceive that the danger exists. Many workplace hazards are not perceived through human sensory channels, e.g.

- excessive pressure inside a boiler that could cause an explosion
- a fork-lift truck approaching from behind in a noisy factory
- unguarded machinery in a poorly lit room
- the sudden release of an odourless toxic gas.

In these situations it is necessary to supplement the sensory functions with special informational displays, e.g.

- a pressure gauge with redline marks to indicate a dangerous condition inside the boiler
- a horn or beeper on the fork-lift truck that sounds automatically while it is in motion
- a well-lit warning sign at the entrance to a poorly lit equipment room
- an emergency alarm system that indicates the release of toxic gases.

(b) Failure in the information processing or decision-making processes

Decision-making involves combining new information with existing knowledge to provide a basis for action. Errors can occur at this stage if the information processing load is excessive, e.g. in the accident at the Three Mile Island nuclear power plant in the USA in the 1970s, operators were required to react to multiple simultaneous alarms.

Errors can also occur if previous training was incorrect or inappropriate for handling a specific situation.

(c) Failure in motor actions following correct decisions

Following a decision, it is frequently necessary for a worker to perform some motor action by using a control to implement the desired change, e.g. flipping a switch or adjusting a knob. Failures can occur if controls are not designed to be consistent with human motor abilities, e.g. the force required to adjust a control valve in a chemical plant should not exceed human strength ability, or if manipulation of the control causes an unexpected response.

Controls that start potentially dangerous machinery or equipment should be guarded to prevent accidental activation, usually by covering the control or placing it in a location where it cannot be accidentally touched.

Tasks for trainees

- Look around your environment and identify three tools, systems, processes or combinations thereof that are faulty from a human factors perspective.
- For each, describe why you think there is a problem and suggest how the problem might be fixed. Limit your response to a few sentences per problem.

3.2 Work physiology

Work physiology is the subdiscipline of ergonomics concerned with stress that occurs during the metabolic conversion of biochemical energy sources, such as glucose, to mechanical work. If this stress is excessive, the worker will experience fatigue. Fatigue may be localized to a relatively small number of muscles or may affect the entire body.

Static work and local muscle fatigue

Static work occurs when a muscle or muscle group remains in a contracted state for an extended period of time without relaxation. High levels of static work can be caused by:

- sustained awkward posture, e.g. a mechanic who must continuously twist his body to perform repairs to an automobile engine
- high strength demands associated with a specific task, e.g. using a wrench to undo a badly rusted wheel-nut when changing a tyre.

When a muscle contracts, the blood vessels that supply nutrients and remove metabolic wastes are compressed by the adjacent contractile tissue. As a result, vascular resistance increases with the level of muscle tension, and the blood supply to the working muscle decreases. If the muscle is not allowed to relax periodically, the demand for metabolic nutrients may exceed the supply. Metabolic wastes can also accumulate. The short-term effects of this condition include ischaemic pain, tremor or a reduced capacity to produce tension. Any of these effects can severely inhibit work performance.

Static work also causes a temporary increase in the peripheral resistance of the cardiovascular system. Significant increases in heart rate and mean arterial blood pressure have been observed in conjunction with short duration static contractions. Caution should be exercised to avoid placing a person with a history of cardiovascular disease on a job that requires moderate to heavy static exertions.

In most situations, dynamic activities involving cyclical contraction and relaxation of working muscle are preferable to static work. If, however, the job requires highly repetitive or forceful exertions, a variety of localized cumulative trauma injuries may occur to musculoskeletal tissue or peripheral nerves.

Dynamic work and whole-body fatigue

Dynamic, whole-body work occurs when multiple groups of large skeletal muscles repeatedly contract and relax in conjunction with the performance of a task, e.g. walking on a level surface, pedalling a bicycle, climbing stairs and moving a load (by carrying, pushing, pulling, or shovelling) from one location to another.

The intensity of whole-body, dynamic work is primarily limited by the capacity of the pulmonary and cardiovascular systems to deliver sufficient oxygen and glucose to working muscles and to remove products of metabolism.

Whole-body fatigue occurs when the collective metabolic demands of working muscles throughout the body exceed this capacity. Common symptoms of whole-body fatigue include shortness of breath, weakness in working muscles and a general feeling of tiredness. These symptoms will continue and may increase until the work activity is stopped or decreased in intensity.

For extremely short durations of whole-body dynamic activity (typically 4 minutes or less), a person can work at intensity equal to his or her aerobic capacity. As the duration of the work period increases, the work intensity must be adjusted downward. If a task is to be performed continuously for 1 hour, the average energy expenditure for this period should not exceed 50% of the worker's aerobic capacity. For a job that is performed for an 8 hour shift, the average energy expenditure should not exceed 33% of the worker's aerobic capacity.

Aerobic capacity varies considerably within the population. Individual factors that determine aerobic capacity include age, sex, weight, heredity and current level of physical fitness.

The prevention of whole-body fatigue is best accomplished through good job design. The energy expenditure requirements of a job should be sufficiently low to accommodate the adult working population, including those individuals with limited aerobic capacity. These requirements can be met by designing the workplace to minimize unnecessary body movements (excessive walking or climbing) and providing mechanical assists (such as hoists or conveyors) for handling heavy materials. If these approaches are not feasible, it may be necessary to provide additional rest allowances to prevent excessive fatigue, particularly in hot, humid work environments because of the metabolic contribution to heat stress.

To assess the potential for whole-body fatigue, it is necessary to measure or estimate the energy expenditure rate for a specific job, which is usually done in one of three ways:

1. Table reference: extensive tables of the energy costs of various work activities have been developed.

2. Indirect calorimetry: energy expenditure can be estimated by measuring a worker's oxygen uptake while performing the job.

3. Modelling: the job is analysed and broken down into fundamental tasks such as walking, carrying and lifting. Parameters describing each task are measured and substituted into equations to predict energy expenditure.

3.3 Occupational biomechanics

Biomechanics is the subdiscipline of ergonomics concerned with the mechanical properties of human tissue, particularly the resistance of tissue to mechanical stress. A major focus of occupational biomechanics is the prevention of the lower back and upper extremities.

Mechanical stress

- Overt accidents: some of mechanical stresses that cause injury in the work environment are associated with overt accidents, e.g. crushed bones in the feet resulting from the impact of a dropped object. The hazards that cause these injuries can usually be controlled through safety engineering techniques.
- Cumulative trauma injuries: other injurious mechanical stresses are more subtle and can cause cumulative trauma injuries. Such stress can be external, such as a vibrating chain saw that causes Raynaud syndrome, or internal, such as compression of spinal discs during strenuous lifting.

Such stress is most effectively controlled through ergonomics, i.e. designing job demands so that resulting mechanical stress can be tolerated without injury.

Biomechanics of lifting, pushing and pulling

(a) Principles of lifting

- Test your personal strength limits and make sure the load to be lifted is below 50% of that limit.
- Avoid lifting loads that exceed the general strength limits calculated for various types of lifting.
- Minimize twisting with a load, and, when it is necessary to twist, rotate the pelvis.
- Keep the load close to the body when lifting it.
- Exercise caution when working in slippery or cluttered areas.

(b) Principles of pushing and pulling

- Make certain that the area ahead of the load is level and clear of obstacles; if it is not level, some system of braking should be available.
- Push the load rather than pull it; this will reduce spinal stress, and in most cases will improve the visibility ahead.
- Wear shoes that provide good foot traction; the coefficient of friction between the floor and the sole of the shoes should be at least 0.8 wherever heavy loads are moved.
- When starting to push a load, brace one foot and use the back, rather than the hands and arms, to apply force; if the load does not start to move when a reasonable amount of force is applied, get help from a co-worker or use a powered vehicle.

- Pushing or pulling is easier when the handles of the loaded cart are at about hip height (91–114 cm for men) than they are at shoulder height or above. Handles lower than the hips are awkward and unsafe to use.

3.4 Use of anthropometric data

One of the primary reasons for physical stress on the job is the mismatch in size between the worker and the workplace, equipment or machinery. This mismatch may result in having to work bent over, having to work with one or both arms and shoulders held high for long periods or having to sit on a stool or bench that is too low or too high.

Anthropometry is concerned with fitting tools and workspaces to the dimensions of the human body. Since humans come in a tremendous range of shapes and sizes, this is often a difficult task. Knowing the distribution of shapes and sizes is the first step in anthropometric design. There are thousands of different measurements on the human body that are relevant to the design of tools, workplaces and even clothing.

Anthropometric tables

Anthropometric tables list summaries of these measurements across different population groups. Numerous anthropometric data sources are available, each representative of the different populations measured, e.g. there are anthropometric databases available on military personnel, American industrial populations and different countries and regions of the world.

Reach and fit

The concepts of reach and fit are essential to anthropometry and they apply in many different situations including design of almost any product or technology people use:

- chairs and seating
- baths, showers, kitchens
- workplaces in general
- computer workstations
- cars and other vehicles
- corridors, stairways and building interiors in general
- tools.

A general rule of anthropometric design is that tall people establish fit requirements, short people establish reach requirements.

Steps in design

1. Defining who to design for (define the population)

Many companies and factories have a diverse population, both within and across workplaces. Therefore the population being designed for must be defined to ensure that the design fits the physical characteristics of the actual workplace population.

2. Determining the important parts and dimensions to use

For design or redesign of equipment, tools, workstations or jobs, body dimensions that specifically relate to the tasks being performed should be used, e.g.

- designing for short-reach distances to obtain parts from bins at a workstation allows smaller employees to reach without forming awkward postures;
- for a seated workstation, using clearance dimensions for the largest male allows most employees to place their legs under the workstation without forming awkward postures, such as leaning or twisting the back.

For the design of new jobs, employers must also determine:

- how the job is going to be performed (identification of the tasks);
- how any new equipment or tools will be used (e.g. location of controls, reach requirements); and
- what body dimensions are important to use for the design.

As a minimum, the dimensions related to work height (the actual height at which the hands perform the work), reach and fit (clearance) should be addressed.

3. Designing for adjustability

This strategy accommodates nearly all the workforce, e.g. an existing work surface that allows a shorter individual to stand and work without bending over might require that a taller individual bend forward to work on the same work surface. A work surface that is adjustable in height allows the taller individual to stand and work without bending. At a computer workstation, adjustability may be considered for the chair, work surface and monitor.

4. Designing for extremes

An alternative approach to designing for adjustability is to design for the extreme (95th percentile male or 5th percentile female) and accommodate the rest of the population, e.g. design the work surface height for the 95th percentile male and accommodate shorter individuals through work stands.

4. TASKS FOR TRAINEES

1. Visit local workplaces for different occupations and record your observations of ergonomic problems.
2. Prioritize your observations and make action plans in light of the discussion in section 2 of this module.
3. Develop, in close cooperation with management and workers, corrective measures/advice/suggestions in order to improve at least the most harmful aspects of the work situation.

4. For problems which cannot be solved, find out where you can refer them to, including specialized centres where possible.
5. Train management and workers how to work with the corrections introduced and encourage follow-up.
6. Check up on exactly how your suggested corrective measures have been implemented.
7. Educate management and workers on what to do in order to avoid physically and psychosocially harmful work situations.
8. Document tasks 1–7.

MODULE 5

Stress and adverse psychological factors at work

1. OBJECTIVES

- Learn how to identify workers with psychological problems
- Learn how to encourage workers with psychological problems to manage their stress by seeking the help of their relatives and friends
- Know how to keep records and write reports
- Assist in simple psychometric tests
- Spot stressors.

2. INTRODUCTION AND BASIC CONCEPTS

2.1 Definitions

Stress: a (perceived) substantial imbalance between demand and response capability under conditions where failure to meet demand has important (perceived) consequences. Stress is also defined as the sequence from stressors to stress reactions and long-term consequences.

Stressor: environmental event or condition that results in stress.

Stressful: pertaining to an environment that has many stressors.

Strain (or stress reaction): short-term physiological, psychological or behavioural manifestations of stress.

Modifier: individual characteristic or environmental factor that may act on each stage of the stress response to produce individual variation.

Psychosocial factors: factors influencing health, health services and community well-being stemming from the psychology of the individual and the structure and function of social groups. They include social characteristics such as patterns of interaction within family or occupational groups, cultural characteristics such as traditional ways of solving conflicts, and psychological characteristics such as attitudes, beliefs and personality factors.

2.2 Common workplace stressors

Organizational

- change
- inadequate communication
- interpersonal conflict
- conflict with organizational goals

Career development

- lack of promotional opportunity
- new responsibilities beyond level
- unemployment

Role

- role conflict
- role ambiguity
- inadequate resources to accomplish job
- inadequate authority to accomplish job

Task

- quantitative and qualitative overload
- quantitative and qualitative underload
- responsibility for the lives and well-being of others
- low decision making latitude

Work environment

- poor aesthetics
- physical exposures
- ergonomic problems
- noise
- odours
- safety hazards

Shift work

2.3 Components of the stress process

Stressors

- Job structure
  - overtime
  - shift work
  - machine pacing
  - piecework
- Job content
  - quantitative overload
  - qualitative underload
  - lack of control
- Physical conditions
  - unpleasant
  - threat of physical or toxic hazard
- Organization
  - role conflict
  - competition
  - rivalry
- Extra-organizational
  - job insecurity
  - career development
  - commuting
- Other sources
  - personal
  - family
  - community

Outcomes

Physiological

- Short-term
  - catecholamines
  - cortisol
  - blood pressure increases
- Long-term
  - hypertension
  - heart disease
  - ulcers
  - asthma

Psychological (cognitive and affective)

- Short-term
  - anxiety
  - dissatisfaction
  - mass psychogenic illness
- Long-term
  - depression
  - burnout
  - mental disorders

Behavioural

- Short-term
  - job: absenteeism, reduced productivity and participation
  - community: decreased friendships and participation
  - personal: excessive use of alcohol and drugs, smoking
- Long-term
  - "learned helplessness"

Modifiers

- Individual
  - behavioural style
  - personal resources
- Social support
  - emotional
  - value or self-esteem
  - informational

3. PREVENTION AND CONTROL OF STRESS

Treat the individual

- Medical treatment
  - hypertension
  - backache
  - depression
- Counselling service
- Employee assistance programmes
  - smoking
  - alcohol
  - drugs

Reduce individual vulnerability

- Counselling
  - individual
  - group programmes
- Training programmes
  - relaxation
  - medication
  - biofeedback
- General support
  - exercise programmes
  - recreational activities

Treat the organization

- Diagnosis
  - attitude survey
  - rap sessions
- Develop flexible and responsive management style
- Improve internal communications

Reduce organizational stress

- Variable work schedules
- Job restructuring
  - enlargement
  - enrichment
  - increased control
- Supervisor training and management development

4. PRINCIPLES OF JOB DESIGN

Work schedule

A work schedule should be designed to avoid conflicts with demands and responsibilities outside the job. When rotating shift schedules are used, the rate of rotation should be stable and predictable.

Participation/control

Workers should be able to provide input into decisions or actions affecting their jobs and the performance of their tasks.

Workload

Demands should not exceed the capabilities of individuals. Work should be designed to allow recovery from demanding physical or mental tasks.

Content

Work tasks should be designed to provide meaning, stimulation, a sense of completeness and an opportunity for the use of skills.

Work roles

Roles and responsibilities at work should be well defined.

Social environment

Opportunities should be available for social interaction, including emotional support and actual help as needed in accomplishing tasks.

Job future

Ambiguity should be avoided in matters of job security and career development opportunities.

5. TASKS FOR TRAINEES

1. Survey workplaces using simple methods and techniques and identify possible and potential stressors in the area.
2. Collect biological and environmental samples concerning physical, chemical, biological and ergonomic stressors.
3. Keep simple records of individual workers as well as of working groups and surveys.
4. In collaboration with the site physician, identify and document workers with psychological problems in the workplace with the help of social workers where available.
5. Assist in simple psychometric analyses and techniques.
6. Practise health education of the workers concerning health problems related to work conditions, personal lifestyles, and mental and psychological states.
7. Try to help people with drug or substance addictions.

MODULE 6

Occupational safety and accident prevention

1. OBJECTIVES

- Understand the importance of preventing accidents in the workplace and support safety professionals' efforts in this regard
- Participate in educating and training workers
- Keep records and analyse the data obtained
- Contribute to the daily work of the occupational safety committee
- Give advice on reducing morbidity, disability and mortality due to occupational accidents and trauma.

2. INTRODUCTION AND BASIC CONCEPTS

2.1 Definitions

Accident: a sudden event that results in an undesired outcome such as property damage, bodily injury or death.

Occupational accident: accident occurring at the workplace which may cause damage to machinery, tools or people.

Injury: physical damage to body tissues caused by an accident or by exposure to environmental stressors. This injury may lead to death and is then called a "fatal accident" or may cause partial disability or lead to sick leave for a period of time.

Hazard: any existing or potential condition in the workplace which, by itself or by interacting with other variables, can result in death, injury, property damage or other loss. Simply, hazard is a potential source of harm.

Risk: the likelihood of harm (in defined circumstances).

Harm: the loss to a person (or people) as a consequence of damage.

Damage: the loss of inherent quality suffered by an entity (physical or biological).

Danger: the degree of exposure to a hazard.

Safety: the absence of danger.

Occupational safety: risk identification at the workplace and preventive measures taken to reduce or eliminate the hazard which may lead to accidents.

Safe behaviour: acting in such a way that no risk of injury is caused by one's behaviour.

Safety professional: a person whose basic job function and responsibility is to prevent accidents and other harmful exposures and the personal injury, disease or property damage that may ensue.

2.2 Aim of occupational safety

The occupational safety philosophy has been developed in order to:

- prevent needless destruction of health and waste of human and other resources
- raise the morale of workers
- prevent inefficiency in the workplace due to the effects of accidents
- prevent social harm caused by accidents
- promote accident prevention.

2.3 Classification of types of occupational accident

Type of accident

- falls or being struck by materials
- striking against objects
- being caught in, under or between objects
- over-exertion or strenuous movements
- exposure to or contact with extreme temperatures
- exposure to or contact with electric current
- exposure to or contact with harmful substances or radiation
- other types of accident.

Agency

- machines
- means of transport and lifting equipment
- other equipment
- materials, substances and radiation
- work environment
- other agencies not elsewhere classified
- agencies not classified for lack of sufficient data.

Nature of injury

- wounds, fractures, dislocations
- burns, poisonings
- diseases.

Bodily location of the injury

- head
- trunk
- upper extremities
- lower extremities
- body system.

Occupation of accident victim(s)

Economic activity in the course of which the accident occurred

2.4 Causes of occupational accidents and injuries

Human factors

There are many varying human factors that have an effect on the accident-risk of the individual at certain times and in certain situations. Some of these factors are: age, experience, use of medicines or drugs, motivation, etc. But most human activity requires avoidance of errors that could result in injuries or material damage. To avoid an accident an individual must observe and recognize danger, decide on a course of action and act sufficiently vigorously to avoid the danger.

The accident may occur if a hazard is not seen, recognized or understood as dangerous, or if one does not take responsibility for personal action, or if one does not know how to act or for other reasons does not decide to act. Even if the right decision is made, the muscular response may be incorrect, ineffectual or too slow.

Environmental factors

These include both the outside agent of injury and other factors of the physical working environment: lighting, noise, temperature, etc.

A necessary cause of injury is contact with a harmful object, substance or energy. An injury may also be caused by a lack of energy, e.g. lack of oxygen in the environment. These injury agents are called hazards. If there is a hazard in the working environment there is always some possibility of an accident. This is the reason why safety technology has the first priority in accident prevention. Hazards should be eliminated or isolated so that there is no risk of accident.

The injury agent, the kind and amount of hazardous energy, is the main determinant of the severity of injury. The following table illustrates some examples.

Selected examples of overt and cumulative trauma commonly affecting occupational groups

Cause	*Injury or disorder*	*Affected occupation*
Overt trauma		
Mechanical energy	Lacerations	Sheet metal workers, butchers, press operators, sawyers, fabric cutters
	Fractures	Materials handlers, miners, construction workers
	Contusions	Materials handlers, any worker exposed to low energy impacts
	Amputations	Press operators, butchers, machine operators
	Crushing injuries	Materials handlers, press operators, construction workers, rubber workers
	Eye injuries (struck by foreign objects)	Miners, grinders, saw mill operators, machine shop employees
	Strains or sprains (overt)	Materials handlers, miners, baggage handlers, mail handlers, construction workers
Thermal energy	Burns	Foundry workers, smelter workers, welders, glass workers, laundry workers
	Heat strain	Firefighters, steelworkers, smelter workers
	Cold strain	Utility workers, lumberjacks, butchers
Chemical energy (including acute toxicity)	Burns	Masons, process workers, hazardous waste workers
	Asphyxiation, acute toxicity	Firefighters, confined space workers, hazard ous waste workers
Electrical energy	Electrocution, shocks, burns	Utility workers, construction workers, electricians, users of electric hand tools or machines
Nuclear energy	Radiation burns, illness	Hospital workers, industrial radiographers, nuclear workers
Cumulative trauma		
Heavy lifting, prolonged awkward posture	Back pain	Materials handlers, sitting, nurses, truck drivers, sewing machine operators
Frequent or repetitive hand motions with awkward posture	Upper extremity cumulative trauma disorders (tendonitis, carpal tunnel syndrome, epicondylitis, degenerative joint disease)	Assembly line workers; forceful garment workers; poultry, meat, or fish processors; clerical workers; press operators; fruit pickers; musicians
Vibration	Raynaud syndrome	Lumberjacks, grinding machine operators, jackhammer operators

Organizational factors

The social environment has a great effect on human performance. The safety management approach to accidents is that the immediate causes (unsafe conditions and unsafe acts) are only symptoms of root causes that exist in the management function. These may be errors in the area of management policy, confusion of goals, staffing, housekeeping, responsibility, use of authority, line and staff relationships, accountability, rules, initiative, etc.

Controlling the frequency and severity of accident occurrence and controlling the quality and quantity of product have much in common. In many cases the same faulty practice is involved, leading to both accident occurrence and unsatisfactory production.

3. RECORDING AND INVESTIGATING ACCIDENTS

Companies and community health workers need to record and investigate occupational accidents in order to:

- identify the real causes of injury, property damage and near-misses
- develop effective methods of preventing future similar accidents
- meet legislative requirements.

The accident or injury report should include the following information:

- circumstances of the accident
- cause of the accident
- available data for assessing the cause of the accident and their effects on the person and the environment
- emergency measures taken
- steps to be taken in the future to prevent further accidents.

Accidents may be reported according to:

- cause of accident
- place of the accident
- type of injury
- personal characteristics such as age, sex and the level of education of the injured
- time of the accident.

The following points should be considered when developing an accident recording and investigating system:

- What reports are required?
- Who is responsible for conducting the investigation?

- Who do reports go to?
- What time-frame should be allowed to complete investigations?
- Are there follow-up procedures to ensure that report recommendations are implemented?
- Have the appropriate authorities been notified?
- What accidents will be recorded and investigated?
- Is a custom-designed form needed?
- Are all injuries recorded in the recording system?
- What training will investigators need?
- Where will records of accidents and investigations be kept?
- Does regular analysis identify similar accidents recurring or other trends?

4. ACCIDENT RATES

Comparison of accidents between time-periods, industries, occupations and countries can be made only if the industrial accident statistics are considered in conjunction with data, including employment, work hours, production, etc. For such purposes it is useful to calculate relative measures such as frequency, incidence, and severity rates.

- frequency rate = total number of accidents $\times 10^3 \div$ total number of work-hours worked
- incidence rate = total number of accidents $\times 10^3 \div$ total number of workers exposed.

Two different severity indicators are recommended:

- the average number of days lost per accident
- the number of days lost per day worked by persons exposed to risk, or, failing that, per person exposed to risk.

In some countries the severity rate is defined as the number of days lost per 1000 work-hours.

Death and permanently disabling injuries are dealt with separately from other accidents in statistics. It is also possible to convert them into lost working days, for example, so that death and totally disabling permanent injury are equal to 6000 lost days.

5. PREVENTION AND CONTROL OF OCCUPATIONAL ACCIDENTS

The basic accident prevention activities are as follows:

- Eliminate the hazard from the machine, method, material or facility structure.
- Control or contain the hazard by enclosing or guarding it at its source or attaching an exhaust pipe to remove airborne hazards from the operator.
- Train operating personnel to be aware of the hazard and to follow safe job procedures to avoid it.
- Prescribe personal protective equipment for personnel to shield them from the hazard.
- Provide advisory services on safety and health problems and other matters related to accident prevention.
- Develop a centralized programme to control accident and fire hazards.
- Keep informed of changes in legislation and safety codes and communicate such information to management.
- Develop and apply safety standards both for production facilities (equipment, tools, work methods and safeguarding) and for products, based on applicable legal and voluntary codes, rules and standards.
- Work closely with the engineering, industrial hygiene, medical, and purchasing departments to ensure that only safe tools, equipment and supplies are purchased.
- Develop, plan and implement a safety and health inspection programme to be carried out by the operating supervisors and field safety personnel to identify potential hazards, both in the workplace and in the use of the company's products.
- Along with representatives from engineering, operating and personnel, inspect all new equipment to ensure adequate health and safety safeguards.
- Guide operating supervision in accident investigation to determine the accident's cause and to prevent recurrence.
- Review non-disabling-injury accident reports on a sample basis to check the thoroughness of the accident investigation and corrective actions taken.
- Collect and analyse data on illness and accidents for the purpose of instituting corrective action and to determine accident trends and provide targets for corrective action.
- Ensure education and training of employees in general as well as specific health and safety principles and techniques.
- Maintain supervisory contacts for new instructions, follow-up and general health and safety motivation.

- Cooperate with industrial hygiene or environmental quality control personnel on industrial hygiene problems.

6. TASKS FOR TRAINEES

6.1 Education

The aim of safety education is to do work in a safe way until it becomes a habit. Audiovisual aids, e.g. lectures, posters, films, videos, slides, radio and television programmes, are very important in safety education.

Use and/or develop audiovisual aids for educating trainees according to safety principles and problems.

6.2 Training

A training programme is needed for new employees when new equipment or processes are introduced, when procedures have been revised or updated, when new information must be made available and when performance of employees needs to be improved.

Retraining is indicated in the following situations:

- high accident or injury rate
- high labour turnover
- excessive waste and scrap
- company expansion (plants or equipment).

Design and/or apply a training course for new employees in a certain industry in cooperation with the safety personnel working in the targeted facility.

6.3 Evaluation of safety legislation

Occupational safety laws, regulations and codes of practice are needed for the workers' safety taking into consideration the responsibility of management and workers with clarification of responsibilities and job analysis. These laws should include measures to be taken to prevent occupational accidents. Safety legislation would be ineffective unless some means could be found to enforce it.

Evaluate local or national safety legislation and its enforcement in the light of management and worker responsibilities.

6.4 Personal protection devices

Personal protection devices are the second line of defence and must be used when engineering controls cannot be used or are inadequate. These include: masks, goggles, safety shoes, helmets, ear plugs, ear muffs, gloves and aprons.

Check on the availability of personal protection devices in certain industries and evaluate the management's and the workers' knowledge, attitudes and practices concerning the role of these means in preventing occupational accidents and injuries.

6.5 Control of electrical hazards

Many accidents occur due to defective electrical apparatus, especially portable electrical apparatus, e.g. sockets, plugs and flexible cable. All switches must have approved voltage and amperage rating compatible with intended use. Circuit breakers should be used when needed. All electrical equipment must be inspected and maintained regularly.

Familiarize yourself with the control systems of electrical hazards in a certain industry and prepare a report evaluating that system.

6.6 Control of fire hazards

Ordinary fire results from the combination of fuel, heat and oxygen. Common fire hazards include smoking, flammable liquids, naked flames, poorly maintained and overheating machines, electrical wiring, static electricity, welding and soldering equipment.

The principles of fire control are to:

- prevent ignition
- store chemicals and explosive materials properly
- install and use fire alarms
- provide fire extinguishing equipment and regularly inspect and maintain it
- train every worker to use the available fire control equipment
- inspect the workplace at regular intervals for fire risks
- conduct regular fire drills
- cooperate with the local fire brigade.

Familiarize yourself with the fire hazard control system in a certain industry and prepare a report evaluating that system.

6.7 Purposes of occupational accident investigation

Investigation and analysis are used to prevent accidents, both those that result in injury to personnel and those that do not. The investigation or analysis of an accident can produce information that leads to countermeasures to prevent accidents or reduce their number and their severity. An investigation of every accident that causes disability or illness should be carried out. Incidents resulting in non-disabling injuries or no injuries and "near accidents" should also be investigated to evaluate their causes in relation to injury-producing accidents or

breakdowns. For purposes of accident prevention, investigations must be fact finding, not fault finding.

Discuss the above mentioned statement in the light of the actual occupational accident recording and investigating system at the local and national levels.

6.8 Types of occupational accident investigation

These are several accident investigation and analysis techniques available. The choice of a particular method depends on the purpose and orientation of the investigation. The accident investigation and analysis procedure focuses primarily on unsafe circumstances surrounding the occurrence of an accident and is the most often used technique. Other similar techniques involve investigation within the framework of defects in the four Ms: man, machine, media and management, or the three Es of safety: education, enforcement and engineering.

Compare and evaluate the existing types of occupational accident investigation in the light of the types mentioned above.

MODULE 7

First aid and its practice

1. OBJECTIVES

- Become acquainted with first aid techniques
- Be able to provide emergency care in the workplace
- Know how to decide to refer cases to a hospital or a specialized health centre
- Know how to perform and practise health education
- Learn how to keep records and write reports.

2. IMPORTANCE OF FIRST AID

First aid is the immediate care given to victims of accidents before trained medical workers arrive. Its goal is to stop and, if possible, reverse harm. It involves rapid and simple measures such as clearing the air passageway, applying pressure to bleeding wounds or dousing chemical burns to eyes or skin. The critical factors which shape first aid facilities in a workplace are work-specific risk and availability of definitive medical care, e.g. the care of a high-powered saw injury is obviously radically different from that of a chemical inhalation.

First aid is a fluid concept not only in what must be done (how long, how complex) but in who can do it. Although a very careful attitude is required, every worker can be trained in the top 10 crucial steps of first aid. In some situations immediate action can save life, limb or eyesight. Co-workers of victims should not remain paralysed while waiting for trained personnel to arrive. The top 10 crucial steps will vary with each workplace and must be taught accordingly.

First aid personnel are persons on the spot, generally workers who are familiar with the specific conditions of work. They might not be medically qualified but they must be trained and prepared to perform very specific tasks. First aid personnel should be selected carefully, taking into account attributes such as reliability, motivation and the ability to cope with people in a crisis situation.

3. INJURIES

3.1 Definitions

Injury: a physical damage to body tissues caused by an accident or by exposure to environmental stressors.

Wound: a break in the continuity of body tissue or opening in the skin. A wound may be an injury but not all injuries are wounds.

3.2 Head injuries

Crucial steps

1. Maintain an airway.
2. Control bleeding.
3. Protect against infection.
4. Prevent further injury.

Then:

- In cases of shock, look for other injuries which may be causing blood loss.
- In case of closed brain injuries, look for symptoms such as unusual behaviour, loss of memory, drowsiness, excitability or delirium.
- Be aware that bruising to the brain may cause convulsion, drowsiness or loss of consciousness.
- Be aware that bleeding from the ears, nose and throat is a result of a fracture at the base of the skull.
- Do not attempt to remove foreign objects embedded in the head as this may cause uncontrollable bleeding.
- Apply head dressings in such a manner that they will not slip off during transportation to hospital.
- Place the patient on his/her side to allow proper drainage.
- In cases of respiratory centre damage, apply mouth-to-mouth resuscitation to ensure an adequate supply of oxygen.

3.3 Facial injuries

Crucial steps

1. Check for obstructed airway as facial injuries may cause external bleeding resulting in blockage of airway. The bleeding from the oral cavity can be particularly heavy.
2. Control bleeding by realigning the jaw, i.e. by grasping the chin and pulling it straight out.
3. Maintain the airway by turning the victim on his/her side.

3.4 Chest injuries

Crucial steps

1. Seal the chest wound from the outside as quickly as possible.
2. Never extract foreign objects from the chest wound.

3. Maintain airway.
4. Administer oxygen.
5. Apply mouth-to-mouth resuscitation and external heart massage if necessary.
6. Transport the patient in a sitting position unless he/she is in shock.

3.5 Abdominal injuries

Crucial steps

1. Cover the wound with a sterile dressing; apply a compression binder to control haemorrhaging.
2. Look for any penetrating wounds and other symptoms such as vomiting, abdominal pain and tenderness.
3. Never attempt to replace protruding organs, cover them with sterile gauze and keep the cloth moist.
4. Place the patient in a semi-sitting position unless he/she is in shock.
5. Keep the patient warm with blankets.
6. Never give the patient anything to drink or eat.

3.6 Eye injuries

- Do not interfere with eye injuries except in minor cases. Refer the victim to hospital immediately.
- Symptoms of serious eye injury are:
  - blurred vision that does not clear with blinking
  - loss of all or part of the visual field of an eye
  - sharp stabbing or deep throbbing pain
  - double vision.
- Signs of eye injury that require ophthalmological evaluation are:
  - black eye
  - red eye
  - an object on the cornea
  - one eye that does not move as completely as the other
  - one eye protruding more than the other
  - one eye with an abnormal pupil size, shape or reaction to light
  - a layer of blood between the cornea and the iris (hyphaema)
  - laceration of the eyelid, especially if it involves the lid margin
  - laceration or perforation of the eye.

Crucial steps

1. Any chemical splashed into the eye(s) must be considered a vision-threatening emergency. Forcibly keep the patient's eyelids open while irrigating with water

for at least five minutes, then refer the patient to an ophthalmologist. Inform the ophthalmologist of the nature of the chemical contaminant.

2. Patch the injured eye lightly with a dry, sterile eye pad. If laceration of the eye is suspected, add a protective shield over the sterile eye pad. Instruct the patient not to squeeze the eye tightly shut because it greatly elevates the intraocular pressure. Calmly transport the patient to the ophthalmologist.

3. Conjunctivitis, with normal vision and a clear cornea, may be treated with an antibiotic eye ointment for several days. If there is no improvement, referral to the ophthalmologist is indicated.

4. Never put eye ointment in an eye about to be seen by the ophthalmologist. The ointment makes clear visualizations of the retina very difficult.

5. Never give a patient a topical anaesthetic to relieve pain, such as from a flash burn. The prolonged use of topical anaesthetic can result in blindness from corneal breakdown.

6. Never treat a patient with a topical steroid unless directed by the ophthalmologist. Topical steroids can make several conditions much worse, such as herpes simplex, keratitis, fungal infections and some bacterial infections.

7. If in doubt as to how severe an ocular symptom sign is, always err on the side of caution and refer the employee to an ophthalmologist for diagnosis and treatment.

4. FRACTURES

4.1 Definitions

Fracture: any break in a bone.

Simple fracture (closed fracture): the skin covers the fracture.

Compound fracture (open fracture): the skin is broken and the bone has direct contact with the open air.

It is essential to remember the following:

1. Do not harm. Unwise attempts by the patient to continue to use a fractured extremity may cause laceration of the soft tissues and may lead to the broken bone penetrating the skin or to the onset of shock.

2. Protect and immobilize. Apply a splint to the fracture so the victim can be moved more comfortably and without causing any further injuries.

4.2 Fractures of the extremities

Crucial steps

1. Place the injured limb in as natural a position as possible before padding and splinting.

2. If the broken bone is not protruding above the skin, apply traction to overcome the muscle and to straighten the limb with minimum pain. If the broken bone is protruding above the skin, do not apply traction to avoid contaminating deep tissues.

3. To control bleeding, apply gentle pressure by covering the wound with a sterile dressing and wrapping with an elastic bandage.

4. Never attempt to set an open fracture. Apply the proper splint before moving the patient.

4.3 Fracture of the spine and pelvis

A spinal fracture may occur in the neck and upper or lower spine and may affect the spinal cord. Symptoms of fracture to the spine include severe back pain and numbness and tingling in the arms and legs. Pelvic fractures are common but hard to spot. They are usually associated with other injuries which may be severe and cause shock. A fractured pelvic bone may pierce the bladder and may cause intestinal obstruction.

Crucial steps

Unless you have been trained in the correct way to move a suspected spinal fracture, do not attempt to move the victim unless leaving him would expose him to further danger.

1. Ensure that the victim has an adequate airway.

2. Transport a patient with a (suspected) broken neck on his/her back on a rigid support.

3. The patient must be moved as a unit by 3–5 men, one of whom must firmly hold the patient's head.

4. To prevent unnecessary movement, place blanket rolls or pillows along the side of the patient.

5. Place a patient with a (suspected) fractured pelvis gently on his/her back on a firm stretcher.

6. Immobilize the pelvic region by bandaging the knee and ankle together firmly with padding placed between the knees for comfort.

7. Wrap a broad bandage or folded blanket around the patient's hips from just above the hip bone to approximately 5 cm down on the thighs.

8. Prevent shock.

5. THERMAL INJURIES

5.1 Burns

♦ There are three main types of burn: thermal, electrical and chemical.

- Estimate the seriousness of the burns by using the Rule of Nine: the head and neck comprise 9% of the skin area; the chest, 18%; the back, 18%; each arm, 9%; and each leg 18% (for the sake of completeness the genitals/perineum comprise 1%).
- First degree burns are superficial with reddening of the skin.
- Second degree burns extend deeply into the skin with redness.
- Third degree burns involve the entire thickness of the skin.

Crucial steps

1. Prevent shock.
2. Do not attempt to remove patient's clothes except in case of a chemical burn.
3. Wrap the patient in a clean sheet to prevent infection.
4. Maintain body temperature.
5. Neutralize the chemical agent if a neutralizer is available.
6. Determine what chemical agents have been the cause of the burns before transferring the patient to hospital.

5.2 Cold

Long exposure to extreme cold results in hypothermia and coma. The initial symptoms of frostbite are tingling, numbness, pain, violated red skin followed by a constant burning and itching sensation and then loss of all sensation in the affected area. Prolonged exposure to extreme cold results in the onset of hypothermia and ultimately, the victim will lapse into a coma.

Crucial steps

1. Immerse the affected part in water heated to between 40 °C and 42 °C.
2. Do not attempt to thaw the affected area.
3. Do not place the victim close to fire.
4. Do not massage the affected area.

5.3 Heat stroke

Factors contributing to heat stroke are: workload, thermal environment, stress, non-acclimatization, poor work conditions, overweight, unsuitable clothing, poor ventilation, dehydration or shortage of water, alcohol consumption, history of cardiovascular diseases or recent prickly heat.

Crucial steps

1. Confirm suspected cases of heat stroke by measuring the body temperature. A person with a temperature between 40 °C and 43 °C would be considered a victim of heat stroke.

2. Sponge with cool water, wrap in cool sheets or towels or blow cool air over patient.

6. POISONING

Crucial steps

1. Induce vomiting as quickly as possible by administering a tablespoon of ipecac syrup except in instances of ingestion of acids, alkalis and petroleum products. Administer water, milk or universal antidotes; water should be used if there is nothing else available. Do not give fluid to an unconscious person.

2. In instances of ingestion of acids, alkalis, petroleum products and other caustics: attempt to identify the specific product, the concentration of the active ingredients and the estimated volume ingested. The product container or labels may be available. A dilutent may be beneficial if given within 30 minutes of a solid or granular alkaline ingestion. Water or milk may be administered, dosages of 250 ml in adults and 15 ml/kg in children. **Induced emesis and attempts at neutralizing the substance by using a weak acid or alkali are absolutely contraindicated**.

3. Administer mouth-to-mouth or mechanical resuscitation if there is difficulty in breathing.

4. If poison is in contact with the skin, remove all contaminated clothing and flood the affected area with water.

5. If poison is in contact with the eyes, irrigate both eyes with large quantities of water.

6. Identify the poisoning material or collect all vomited material in a container and transport it to the hospital with the patient for laboratory analysis.

7. HAEMORRHAGE

Haemorrhage may be arterial, venous or capillary.

Crucial steps

1. Apply pressure with fingertips to the pressure points and a bandage as necessary.

2. Apply tourniquet **only** when other methods fail and in the case of a life-threatening haemorrhage.

3. A tourniquet should consist of a flat band at least one inch wide such as a tie, handkerchief, towel, scarf or belt. Never use rope or wire. It should only be applied in two places depending on the site of the injury:

   – the arm, a hand's width below the elbow; or
   – the leg, a hand's width below the groin.

8. SHOCK

Shock means there is not enough blood circulating through the body. Symptoms of shock include: pale, cold and moist skin, shallow breathing, bluish fingernails and lips, thirst and restlessness.

Crucial steps

1. Treat shock by removing the cause: stop the bleeding, relieve the pain, splint the fracture.
2. Prevent infection and maintain body heat.
3. Lay the patient flat.
4. Burn victims suffering from shock should be given liquids in small amounts.

9. IMPAIRED BREATHING

Mouth-to-mouth resuscitation

1. Clear the mouth and the throat of any dentures, mucus, food, blood or other obstructions.
2. Tilt the head back as far as possible and stretch the neck.
3. Lift the lower jaw forward.
4. Pinch the nose.
5. Open your mouth wide sealing your lips over those of the victim, take deep breath and blow forcefully until you see the victim's chest rise.
6. Remove your mouth when you see the victim's chest rise; listen for exhalation.
7. Continue the same procedure 12–20 times per minute.

10. TASKS FOR TRAINEES

1. Familiarize yourself with the theory of first aid.
2. Practise first aid procedures with the workers.
3. Know how to perform first aid techniques and artificial respiration.
4. Know how to decide to refer cases to the hospitals or emergency health centres when required.
5. Keep health records of individual workers.

MODULE 8

Health education in occupational health

1. OBJECTIVES

- Describe patterns of occupational diseases and accidents
- Describe how different conditions within work environments may be related to occupational diseases and how to reduce the risk
- Identify causes of work accidents and methods of prevention
- Describe how different styles of work practices might affect the health of the worker, colleagues and others
- Discuss risk reduction of occupational diseases and accidents with workers and managers in the workplace and identify suitable procedures to maintain a healthy work environment
- Discuss how lifestyle and behaviour might affect health
- Describe various new methods of health education and how, when and where to apply them as well as ways of motivation
- Describe the health education tasks the health worker is going to apply and perform in different health problem situations in the workplace
- Identify psychological, cultural, religious and ethical values which might affect the community health worker's ability to educate workers or workplace managers on the work environment and prevention and control of occupational diseases and accidents.

2. OCCUPATIONAL DISEASES

2.1 First steps

Explain to the trainees the definition of occupational disease and its causes:

- chemical agents: gases, vapours, mists, pesticides, etc.
- physical agents: noise, vibration, heat and cold stress, radiation, light, etc.
- biological agents: bacteria, parasites, fungi, allergens, etc.
- psychological factors: interpersonal and social effects, relationship with management, shift-work, etc.
- ergonomic factors.

- Discuss the routes of entry of noxious agents (skin, inhalation, ingestion) and their forms (dusts, gases, vapours, fluids etc.).
- Refer to the importance of the early detection of health impairment and the main signs and symptoms of some common occupational diseases in the locality.
- Discuss the types of medical examinations (pre-placement, periodic and routine), their importance and methods of implementation.

2.2 Methodology

Ask the trainees to pair up with someone in the group. Then direct them (in the pairs) to discuss the following questions. One member of each pair should write down their answers.

Questions:

1. In your opinion, what are the occupational diseases you would expect to find in your district and why?
2. Do you think that it is important to prevent occupational diseases?
3. Whether you answer yes or no, explain why.

Next, ask each pair to join up with another pair in the room. Any left-over pair can join any of the groups of four. Give them some further time to continue their discussion in the small groups. Then ask for feedback to the class concerning:

1. The occupational diseases they expect to be found in their districts and why.
2. The social and economic effects of occupational diseases.

3. OCCUPATIONAL ACCIDENTS

3.1 First steps

- Explain the definition and the causes of occupational accidents, e.g. slipping, tripping up, falls of material and people, machinery, transport, electricity at work, confined spaces, fires and explosions, personal factors.
- Explain that there are ways of minimizing the risk of accidents. Discuss safe and unsafe worker behaviour. Stress the importance of tidiness and hygiene in the workplace in accident prevention.
- Explain primary first aid steps in the case of work accidents and how to refer cases urgently for medical support.
- Discuss rehabilitation, compensation and economic loss due to accidents. Discuss the roles of the employer, workers and government in accident reduction.

3.2 Methodology

1. Stick signs reading "Dangerous" and "Safe" on the board some distance apart. Prepare in advance a large number of cards or strips of paper. On each card write or draw a particular situation, either dangerous or safe, e.g.

   - ♦ oil spills on the workplace floor
   - ♦ covered machinery
   - ♦ exposed electrical wires
   - ♦ heavy boxes which are precariously placed on a moving fork-lift
   - ♦ wearing of loose clothing with loose belts or strips of fabric near revolving machine wheels
   - ♦ other situations which may be relevant to your group of trainees.

2. Hand out the cards at random to members of the groups and ask them to stick their cards on the board at a point under the sign to which they feel it belongs. You can help if the group cannot decide where to fit a certain card. Each person who goes up to the board is encouraged to say whether he disagrees with the position of any cards that are already there.

3. Finally, move any cards that are incorrectly placed and explain your reasons for doing so.

3.3 Case history

There are five workers in a car repair workshop in your town. One of these workers had an accident while testing the revolving parts of a truck engine. He had a deep cut in his left hand, was losing a lot of blood and was in severe pain.

3.4 Methodology

- ♦ Divide the class into groups of five with an elected leader and a reporter and acquaint them with the case history.
- ♦ Ask the class to discuss the necessary steps that the colleagues of the injured worker should take in order to help him.
- ♦ Give enough time for group discussion and jotting down of comments, then ask the reporters to give feedback to the class.
- ♦ Following the feedback from the groups, lead the class in a general discussion on the topic. Confirm that only essential first aid should be given, i.e. to stop bleeding by wrapping the hand with a piece of clean cloth above the wound site. Then, either an ambulance should have been called or the victim should have been transported as quickly as possible to the nearest clinic or hospital for further medical treatment.

4. WORK ENVIRONMENT AND CONTROL MEASURES IN THE WORKPLACE

4.1 First steps

- Explain to the trainees the definition of the work environment and the factors which affect it: physical, chemical, biological and ergonomic.
- Discuss the risks involved when there are uncontrolled conditions.
- Describe the methods of evaluation of the work environment (measurements and interpretation of results) for noise, heat and cold, illumination, radiation, air pollutants, gases, vapours and particles (air sampling).
- Discuss ways of minimizing the health risks in all types of environment through control measures (anticipation, recognition, evaluation and control) and accident prevention. Point out that threshold values should be followed.
- Discuss the importance of periodic inspection of the workplace. Use of standard forms and questionnaires should be highlighted.

4.2 Methodology

Visit to an occupational hygiene laboratory

- The hygienist or responsible technician at the laboratory should brief the trainees on the equipment used for work environment measurements, e.g. noise level meters, light level meters, dust samplers, gas samplers, etc.

Visit to factories/workplaces

- Select three or four factories/workplaces which have different industrial activities and work environment hazards.
- Obtain permission from the factory management to bring the trainees on a visit and fix the date and time.
- Prepare a form for the factory/workplace inspection using the Factory Inspection Guidelines below.
- On the visit day, distribute a copy of the form to each group of trainees.
- Instruct each group to nominate a leader and a reporter.
- On arrival at the factory, instruct the group to question the designated factory contact person using the prepared form.
- The groups then tour through the different parts of the factory, filling in the rest of the form as they go.
- All groups return to the classroom and the reporters from each group provide feedback on their findings.

- Lead a class discussion emphasizing the following points:
  - the work environment
  - workplace hygiene
  - working conditions
  - use of protective equipment
  - need for health education programmes
  - feedback to management

4.3 Factory/workplace inspection guidelines

- Name and address of the factory/workplace
- Industrial activity
- Raw materials used
- Final products
- Number of workers
- General hygiene of the workplace
- Safe-place approach
  - equipment
  - machinery "guarding enclosure"
  - ventilation
  - others
- Exposure hazards and risks
  - physical
  - chemical
  - biological
  - ergonomical
- Safe-person approach
  - systems of work
  - on-the-job training
  - personal protection
- Pre-placement and periodic medical examinations
- Applied health education programmes
- Need for health education programmes
- Other points.

5. PREVENTION OF OCCUPATIONAL DISEASES AND ACCIDENTS

5.1 First steps

- Discuss with the trainees the importance of the workplace site, the building engineering plan and the layout of machinery (safe-place approach).
- Ask the trainees which methods would be suitable to maintain health standards in the workplace.
- Discuss the importance of work practices education and job training for workers (safe-person approach).
- Emphasize the importance of maintaining good workplace hygiene and personal hygiene.
- State the benefits of pre-placement and periodic medical examinations.
- Discuss the roles of employer, worker and government.
- Explain the vital role of health education in occupational disease and accident prevention.

5.2 Methodology

Equipment

Bring to class a collection of personal protective equipment, e.g. gloves, masks, goggles, helmets, boots, aprons, etc., and discuss with the trainees the various types of equipment and their benefits in prevention of occupational disease and accident. Invite the trainees to try on the equipment in order for them to understand how they are used.

Posters

Prepare and display posters showing workers following safe work practices: correct method of weight lifting, wearing masks, goggles and gloves, etc., and poor work practices: workers standing in front of unprotected revolving machinery parts, workers without protective equipment while exposed to gases, dusts, noise etc.

Discussion

Lead the class in discussion of these posters. Encourage the trainees to comment on each poster and whether or not they agree with the work practice indicated by the educational message. If they don't agree with the work practice, invite them to suggest improvements.

6. LEGISLATION

6.1 First steps

- Inform trainees of the laws governing work environment and work practices written by the ministry of labour, ministry of health, ministry of industry, ministry of social security, etc.
- Discuss work accidents and occupational disease compensation and rehabilitation legislation.
- Mention the role of the worker, employer and the government in the settlement of these issues.

6.2 Case history

Mr A is a worker in an iron workshop. He had a work accident in which he damaged two bones in his right index finger. He had to be treated in the district hospital.

6.3 Methodology

- Divide the class into small groups with an elected leader and a reporter.
- Acquaint the trainees with the case history outlined above.
- Instruct trainees to discuss the advice they would give Mr A on any administrative or legislative steps he should take.
- Ask the groups for feedback.
- The trainees should conclude that after Mr A has completed his treatment, he should forward documentation outlining his injury to the labour office or the social insurance department in order to claim compensation and/or rehabilitation treatment.

7. EFFECTS OF LIFESTYLE AND BEHAVIOUR ON HEALTH

7.1 First steps

- Tell the class that in this session they are going to learn about the effects of individual/community lifestyles and behaviour on health conditions. In many instances, whether at home or at work, people can become ill or remain healthy as a result of their behaviour and attitudes.
- Encourage trainees to give examples of correct health behaviour, e.g. washing of hands and utensils with soap; storing of inflammable materials away from work-sites, wearing protective clothing when required and covering food against flies.

- Ask the trainees to discuss what makes people behave in certain ways. Ask them to give examples of the causes of such behaviour and suggest possible reasons behind the causes. Mention the main factors that influence and direct people's behaviour: knowledge, beliefs, attitudes and values.
- Tell the class that it is essential to understand the reasons behind a community adopting a particular behaviour which may protect it from or cause disease, in order to effectively use health education to encourage changes in behavioural patterns.
- Ask the trainees to name a current health problem in their workplace or community and then consider, in a class discussion, the most suitable educational methods to deal with this problem most effectively.

7.2 Case history

In a glass manufacturing factory called X there is a powerful electricity generator which supplies the factory with electricity in case of major power cuts or need for more power supply. The three operators of the generator had a course in health education covering noise hearing loss and noise control measures. During work shifts they regularly use earmuffs and schedule their noise exposure time.

Another factory Y also has a generator of the same size which is used for the same purposes. But the three generator operators have not had a course in health education about noise hearing loss and noise control measures. They do not use earmuffs regularly nor do they schedule their noise exposure time.

After 5 years the group in factory Y have started having hearing problems and defects.

7.3 Methodology

- Divide the class into small groups with an elected leader/reporter.
- Acquaint each group with the case history outlined above.
- Instruct the groups to discuss the following:
  - the behaviour of both groups of factory workers and their hearing problems
  - the personal behaviour in both situations
  - the link, if any, between the behaviour of each group and the conditions in the factory.

8. HEALTH EDUCATION IN THE WORKPLACE

8.1 First steps

- Remind the trainees that the work environment can affect workers' health through exposure to chemical, physical, biological and ergonomic hazards.
- Explain that a successful health educator:

- talks to managers and workers and listens carefully to their problems
- thinks about attitudes which can cause such problems or solve them or protect them
- discovers the reasons for people's behaviour and health problems
- invites workers to give their ideas on solving the problems
- in conjunction with the workers, looks at these ideas and decides which ones are beneficial, practical and easy to apply
- encourages factory managers and workers to select ideas appropriate to their circumstances.

♦ Discuss the following points which are important when establishing a health education programme:

- establishing good working relationships: how to encourage cooperation and participation
- health education planning in PHC: information collection, problem identification and understanding, prioritization, objectives and procedures to be followed, resource identification and mobilization, encouraging proper action and follow-up, selection of suitable health education methods, results evaluation and revision of planning procedures
- individual health education: counselling
- group health education
- community health education
- the importance of conveying the educational message at the right time and place with worker participation and good subject preparation and the need to test it in small groups before general application.

♦ Tell the class about the principles on which PHC and health education in the workplace can be organized.

♦ Emphasize that the aims of workers' education should be to develop the capacity to construct an operational system capable of reducing occupational hazards. The effectiveness of such a system should be assessed by determining to what extent the incidence of health injuries, disease or disorders is diminished.

♦ Explain that to effect this a number of steps should be taken:

- provide the necessary documentation
- make use of the workers' experience
- define priority hazards
- draw up the criteria for workplace improvements
- set the specific objectives to be achieved
- test the effectiveness of control measures.

♦ Introduce the idea that health education safety courses should be specifically designed and held for foremen and group leaders. Periodic meetings should be held by them with factory managers, factory health personnel and safety officers to study the preparation made for safety campaigns and to consider accident statistics, the causes of accidents, risks to health and how to eliminate them.

- Review the briefing that workers should receive when they join the workplace, including an information leaflet informing them of:
  - internal traffic routes (if applicable)
  - detailed descriptions of the work they will be doing and the tools and raw materials they will be handling, as well as their dangers and the precautions that need to be taken
  - general safety regulations
  - special safety rules for different types of work
  - individual and group safety equipment
  - the need to call for first aid at once in the event of an accident and where such help can be found
  - a balanced diet and safe sanitation.

This information leaflet should be reviewed from time to time and commented on by the shop floor. Any relevant incidents should be used by the trainer as a basis for a safety lesson, reinforcing the safety and health instructions.

8.2 Case history

There are 200 workers in a cement factory in your district. During the summer months workers complain of muscle pain (cramps), headaches and fatigue. In the last month of the summer, four workers are diagnosed by the district physician as suffering from heat exhaustion.

8.2 Methodology

- Divide the class into small groups with an elected leader/reporter.
- Acquaint the class with the case study above.
- Instruct the groups to study the case history and plan a health education programme for the workers of the factory. Remind them to mention all the necessary steps they took in order to implement a successful programme.
- After sufficient discussion time, the reporters should provide feedback to the group and general discussion should follow.

9. HEALTH EDUCATION METHODS AND AIDS

9.1 First steps

- Explain the two methods of health education—direct and indirect—and discuss the merits and drawbacks of both.
  - Direct method: a person giving information to individuals or groups who are present in the same place.
  - Indirect method: the person conveying the message is remote from those who are receiving it, e.g. television, broadcasting, Internet magazines, books.

Discuss the interactive teaching strategies required in order to allow instruction, practice, feedback and motivation to take place:

- presentation
- large group discussions
- small group discussions
- role play
- case studies
- fact finding
- project work
- questions.

- Discuss the different aids by which a health education message can be conveyed:
  - Visual aids: boards or large sheets of paper or flip-charts, photographs, posters, publications, newspapers, magazines, transparencies used on an overhead projector, slides and slide projectors, real objects, models.
  - Audio aids: recorded tapes.
  - Audiovisual aids: video tapes, cinema films, role play, exhibitions, dummies.

9.2 Case history

The ministry of agriculture has an agricultural scheme in your district area. The scheme uses different groups of pesticides in order to control insects that are harmful to the plants. The chemicals are also used against pests such as rats, birds etc.

Last week the spraying teams, consisting of 15 workers per team, started an organophosphate insecticide plant spraying campaign. They were provided with protective clothing but some workers did not wear it. They had breakfast and lunch breaks during the course of the day. When the work was complete some of them went home still wearing the clothes they had worn while spraying.

Two days ago, four of these workers reported to the nurse of the local project clinic with respiratory problems and headaches. The provisional diagnosis was insecticide intoxication. There were no antidotes to organophosphate insecticide in the clinic. The affected workers were referred to the district hospital, 50 kilometres away, for further follow-up and treatment.

9.3 Methodology

- Hold a practical class session demonstrating the use of teaching aids.
- Alternatively arrange a visit to the nearest health education centre where the trainees can see the educational aids in use.
- Acquaint the trainees with the case study above and divide them into three groups with a leader/reporter. Ask each group to develop a health education programme for this situation.

- The trainees must use at least one aid (more if desired) from each of the educational aid categories: visual, audio, audiovisual.
- Ask the trainees to consider the following:
  - What information are you conveying through these aids?
  - To which groups?
  - How are you planning to use these aids?
- Give the groups sufficient time to develop their programmes and to prepare their aids. Move between the groups offering direction and advice.
- Ask the groups to present their health education programmes using the three types of aids as required.
- Following this, hold a class discussion on how well each group arranged and presented the required programme and how well they made use of the available educational aids.

10. COMMUNICATION SKILLS IN HEALTH EDUCATION

10.1 The communication process

- Explain to the class that when we want to convey a health message to a person or a group of persons, we need a communication process. When the target audience understands the message in the way we want, then the communication process has been successful. Education is primarily a matter of communication.
- The most important communication skills are:
  - establishing good relationships with people
  - speaking clearly and making use of relevant vocabulary
  - listening attentively
  - ensuring that the message has been clearly understood and explaining further if necessary
  - using non-verbal communication tools efficiently
  - refraining from bias and prejudice
  - refraining from direct criticism of others and hurtful comments
  - maintaining confidentiality if necessary
  - being fully prepared when communicating the message
  - adjusting the level of teaching to suit the recipients
  - using suitable educational aids
  - leading meetings competently.

10.2 Methodology

- Write two signs on the blackboard: “Correct” and “Wrong”.
- Prepare cards, each naming a type of behaviour in communication skills, and perhaps a few words of explanation (see list below).
- Hand the cards out randomly to the trainees.

- Ask the trainees to place their card on the blackboard under the relevant sign. If they are unsure they can pass their card on to someone else. The trainees are free to disagree with each other.
- Finally, remove any cards which are clearly incorrectly placed and hold a general discussion on the different situations and the correct options.

10.3 List of communication skills and behaviour

1. Speaking in a positive manner when addressing a large group.
2. Shouting angrily at an audience.
3. Failing to respond when asked a valid question about a work environment.
4. Taking sides with one or two persons in a group even when they are not giving suitable answers.
5. Openly criticizing students who give incorrect answers.
6. Giving correct information in a logical calm manner after a student's incorrect answer.
7. Discussing openly confidential matters made known to the trainer during a personal counselling session with a student.
8. Thorough preparation of lessons before the class begins.
9. Using unusual terms in a farmers' health education session.
10. Speaking above the educational and comprehension level of the target group.
11. Electing a well informed student to lead a group discussion.
12. Using role-play as a tool to educate illiterate farmers on the control of biological work hazards.

11. TASKS FOR TRAINEES

1. Show skills in giving health education to workers in a workplace.
2. Know the types of occupational diseases and accidents that occur in your district.
3. Show skills in designing posters and preparation of handouts to workers.
4. Show skills in group discussions.
5. Show good communication skills with workers, managers and employers.
6. Know how to use and apply suitable aids for use in health education programmes.
7. Know how to give and discuss the main points found in work legislation with regards to work relations, occupational diseases and accidents, rehabilitation, compensation, workplace inspection, etc.

MODULE 9

Epidemiology and biostatistics in occupational health

1. OBJECTIVES

- Understand the purpose and accept the importance of occupational epidemiology and biostatistics in discovering causes, measuring risks and determining priorities in intervention and evaluation;
- State the characteristics of epidemiology which distinguishes it from other perspectives;
- Discuss the application of biostatistics in epidemiological studies;
- Describe the main types of study design used in occupational epidemiology.

2. DEFINITIONS

Occupational health may be considered to be a component of public health. Epidemiology and biostatistics are key disciplines in public health. Whereas clinical medicine tends to be concerned with the investigation and management of an individual patient's problem, population-based studies are an integral part of occupational health practice.

Epidemiology: the study of the distribution and determinants of health-related states and events in populations and the application of this study to the control of health problems.[1] The fundamental goal of these investigations is to obtain a valid and reasonably precise estimate of exposure–disease association in groups. "As applied to occupational health, epidemiology thus has the dual task of describing the distribution of deaths, accidents, illnesses and their precursors … in the workforce … and of searching for the determinants of health, injury and disease in the occupational environment."[1]

Occupational epidemiology: the study of the occurrence of disease in relation to work-related determinants. It follows that, in reviewing any individual with a health-related problem or any workplace with a hazardous environment, the investigator must ask the following questions:

- Who is at risk?
- Where?

---

[1] *Epidemiology of work-related diseases and accidents. Tenth report of the Joint ILO/WHO Committee on Occupational Health.* Geneva, World Health Organization, 1989 (WHO Technical Report Series No.777).

- When?
- How?

Biostatistics: the discipline of statistics concerned with the description, summarization and interpretation of data as well as the development of procedures to accomplish these objectives.

Occupational biostatistics: an important tool in the quantitative study of morbidity and mortality in humans, relative to exposure in the workplace.

Random sample: a sample of size *n* selected from a larger population is random if each individual within the population has equal probability of being selected. When a sample is not random, the occurrence of the characteristic being investigated may be related to the likelihood that an individual was selected for the sample. Therefore, it is necessary to assess bias and selection factors carefully before generalizing from the results of a study based on non-random samples.

Arithmetic mean: usually denoted as $\bar{x}$, the arithmetic mean is a measure of the central tendency of the data. It is given by the formula:

$$\bar{x} = \frac{x_1 + x_2 + ... + x_n}{n}$$

If the sample is randomly selected from a large population, $\bar{x}$ estimates a population mean usually designated as μ.

The arithmetic mean is strongly affected by extreme values in the data. If a variable has a fairly symmetric distribution, the mean is used as the appropriate measure of central tendency.

Median: the "middle" observation, or 50th percentile, i.e. half of the observations lie above the median and half below.

Mode: the most frequently occurring observation. It is rarely used except when there are a limited number of possible outcomes.

Standard deviation: usually denoted as *S*, the standard deviation is a measure of the "spread" of the data about *x*. It is given by the formula:

$$\sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}$$

The square of the standard deviation, s^2, is the variance. If the sample is randomly selected from a larger population, s and s^2 estimate the population parameters σ and σ^2.

Bias or systematic error: usually a result of flaws in the study design or data collection.

Confounding: the effect of an extraneous variable that may partially or completely account for an apparent association between a study exposure and disease.

3. BIOSTATISTICAL DATA

3.1 Types of data

Data collected in medical research can be divided into three types: nominal (categorical), ordinal and interval (continuous).

Nominal (categorical) data: data that can be divided into two or more unordered categories, e.g. sex, race, religion. In occupational health, many outcome measures such as cancer rates are considered separately for different sex and race categories.

Ordinal data: one step up from nominal data, the difference being a predetermined ordering underlying the categories. Examples of ordinal data are clinical severity, socioeconomic status and ILO profusion category for pneumoconiosis on chest X-ray.

Both nominal and ordinal data are examples of discrete data.

Interval data: Also called continuous data, interval data are measured on an arithmetic scale. Examples include height, weight, blood lead and forced expiratory volume. The accuracy of the number recorded depends on the measuring instrument and the variable can take on an infinite number of values within a defined range.

3.2 Sample size

The number of subjects needed to assess the potential exposure–disease relationship is a fundamental issue when planning a study. The larger the sample size, the greater the power to detect a specified difference in magnitude between an exposure and a disease when it exists.

3.3 Chance variation

This refers to the natural variation in health outcomes observed among similarly exposed individuals. Two statistical tools used for assessing the role of chance are the *P* value and the confidence interval.

The *P* value is the probability of obtaining by chance alone a difference in disease rates between the exposed and unexposed as large as or more extreme than what was observed. A *P* value of 0.005 means that the probability of obtaining by chance alone an exposure effect as large as or more extreme than what was observed is only 5 per 1000. Small *P* values (below 0.05) are sometimes referred to as statistically significant.

The confidence interval (CI) gives the plausible values for the actual effect of exposure with a desired degree of confidence, e.g. the 95% confidence interval for the risk associated with an occupational exposure is an interval in which the true relative risk will be included 95% of the time. A 95% confidence interval that includes 1.0 implies that a value of 1.0 for the relative risk is plausible and thus the null hypothesis of no exposure effect is consistent with the data.

3.4 2 × 2 table

The simplest statistical technique, the 2 × 2 table, is useful when occupationally exposed and unexposed individuals are followed for equal amounts of time for disease incidence.

4. TYPES OF EPIDEMIOLOGICAL STUDY

Epidemiological studies measure the risk of disease directly in human populations. There is no need to rely on questionable extrapolations across animal species to estimate the impact of an exposure in humans. It is possible in epidemiology to examine the consequences of an occupational and environmental exposure in the manner in which it actually occurs in humans, not the artificial manner in which laboratory studies of animals are done. The issue of dose, route of exposure, concomitant exposures and host factors are also directly assessed.

In essence there are three types of epidemiological study although, in practice, the third is undertaken rarely, for ethical reasons.

- **Descriptive studies**: these describe events based on observation and should lead to the development of causal hypotheses, which can be tested.
- **Analytical studies**: these involve the testing of hypotheses. If a hypothesis seems to be supported, attempts should be made to refute it in further studies and/or to undertake intervention studies.
- **Intervention studies**: these are undertaken to see whether an alteration of exposure produces a change in the health outcome of the exposed population.

The cohort study is the most common type of study in occupational epidemiology. Information on a factor (or factors) is collected in a defined population that is followed over time for the occurrence of a disease (or diseases). The disease rate among those exposed is compared to the rate among the non-exposed to assess if there is an association between the study factor and disease. This study takes a long time to complete as investigators have to wait sometimes years before acquiring enough cases of disease (or death). A retrospective cohort study may be used to eliminate this long follow-up period. Past records of individuals are used to characterize the exposure status of the study objects and the disease status is determined until a particular date.

The major methodological advantage of the cohort study is that information on exposure is recorded before the development of disease. This eliminates recall bias.

The case–control study examines two groups. One group consists of people with a particular disease and the other consists of those from the source population or study base without the disease. Information regarding past exposures and habits is obtained from each person in the two groups. If the exposure of interest is reported by a larger proportion of cases than controls, an association between the exposure and disease can be said to exist. Case–control studies are more efficient and suitable for the study of rare diseases and diseases with long latency periods.

In the **cross-sectional study** people are selected regardless of exposure or disease status. This study design is often called a survey or prevalence study.

5. COMMON MEASURES OF DISEASE FREQUENCY

5.1 Introduction

The number of individuals with a diagnosed disease or with abnormal test results, in general, cannot be interpreted without some additional information. An exception to this rule is the occurrence of a disease that is so rare that any case is unusual, e.g. three cases of hepatic angiosarcoma diagnosed among about 270 workers during a three-year period were sufficient to make a plant physician suspect that the vinyl chloride they were exposed to was a carcinogen.

5.2 Crude rates

A rate is the frequency of a disease per unit size of the group (or population) being studied.

Point prevalence rate: the simplest rate based on the number of cases present at one point in time.

Prevalence rate = the number of cases present at a given point in time ÷ the total population at risk at that given point in time

This rate can be compared with a general population rate or rate from an appropriate control group to determine if it is excessive. A limitation of prevalence rate alone, however, is that it counts all cases of the disease without differentiating between old and new cases.

Incidence rate: a rate that removes the background cases and focuses more clearly on new or recent events. It is based on the number of new cases occurring over a specified period of time.

Incidence rate = the number of new cases of disease during a given period of time ÷ the total population at risk during that time

Person–years: When the incidence rate is intended to measure disease onset occurring in the group at risk over the course more than 1 year the appropriate denominator is person–years. This value simultaneously takes into consideration the number of individuals and the time period over which they were observed and considered at risk of developing the disease. It therefore permits the inclusion of individuals who were not at risk for the whole time period. This is particularly important when new employees or terminations of contract are counted or when risk in a specific time period is evaluated.

5.3 Specific rates

In some instances, a crude or adjusted rate for the entire population may obscure an important association. When opposite trends exist in different parts of the age spectrum, these trends may offset each other and be masked by a summary rate.

5.4 Comparison of rates

Independent of whether rates are represented by homogeneous subgroups or adjusted for appropriate variables in the entire group, the rates must be translated into risks to evaluate the effects of exposure.

The two major types of risk estimates based on comparisons of rates are the ratio of rates (relative risk) and the difference between rates (attributable risk).

The **relative risk**, or rate ratio, is designed to communicate the relative importance of an exposure by comparing rates from an exposed population to an unexposed or normal population. In its simplest form, it is the ratio of two rates.

The **attributable risk**, or risk difference, is designed to communicate the amount of disease that can be attributed to the exposure under study. This concept is particularly useful and necessary in occupational disease studies because few diseases can be attributed solely to an occupational exposure. The attributable risk is calculated by subtracting the rate of particular disease in the normal or unexposed population from that in the exposed population.

6. TASKS FOR TRAINEES

6.1 Question 1

The data in the table below show the distribution of days absent from work among workers in four selected industries. Calculate the mean, median and mode duration of absence in each industry. Comment on the difference between industries.

Period of absence (days)	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Total*
Industry												
A	–	–	16	113	36	5	4	2	1	–	1	178
B	–	1	1	2	2	–	27	–	–	–	–	33
C	–	–	12	33	20	28	35	7	1	4	6	146
D	–	97	6	2	6	28	11	27	2	1	4	184

6.2 Question 2

A survey of female textile workers showed that 8% had bacteria in their urine.

- Formulate the study question.
- Specify additional information you need to determine if a health problem exists.
- Identify whether or not the study questions are epidemiological issues.

6.3 Answer to question 1

Industry	*Mean*	*Median*	*Mode*
A	3.35	3	3
B	5.42	6	6
C	4.84	5	6
D	3.26	1	1

6.4 Answer to question 2

- What is the prevalence rate of bacteriuria in female textile workers?
- The expected prevalence rate for a comparable group of women is needed.
- It is an epidemiological problem.

MODULE 10

Record keeping

1. OBJECTIVES

- Be aware of the importance of record keeping and reporting in occupational health;
- Keep records on workers' health and report the results of investigations as required;
- Be acquainted with the coding systems used in record keeping.

2. PURPOSE AND TYPES OF RECORD

2.1 Purpose

No matter how small an occupational health service is, record keeping is a necessary part of its activities. Records are never an end in themselves; they are tools that fill a need. In an occupational health service, records are used for:

- documentation of an employee's exposure to hazards
- employee health data for job placement
- documentation of employee health overtime
- provision of employee health overtime
- fulfilment of regulatory requirements.

2.2 Types

There are seven types of basic record on workers' health. The keeping of some of these records may be required by law in some countries. PHC workers must be told the statutory requirements with respect to keeping records on workers' health.

Health and safety inspection

These records must contain the date, the person carrying out the inspection and the findings of the inspection. In designing the inspection record form, it is advisable to consult with the district health centre as it may be interested in producing a form for all workplaces in the area.

Environmental monitoring

This is only applicable to places which require environmental monitoring on a routine basis. The scheme of monitoring is devised by either the occupational health and safety committee in the workplace or by the district health centre. This includes

the form for keeping records. The PHC workers are trained to take readings with simple instruments and record them systematically. The records are handed over periodically to experts for interpretation.

Health monitoring

This is only applicable to certain groups of workers in some workplaces. The PHC workers are trained either to collect specimens periodically and send them to the designated laboratories for analysis, or to arrange for the workers to have their specimens taken and examinations done periodically in designated laboratories. The PHC workers are responsible for keeping the records supplied by the designated laboratories systematically and for submitting them to the occupational health and safety committee in the workplace or the district health centre for information and any action which may be required.

First aid provided in the workplace

First aid treatment records are often kept at the first aid station at each work site rather than at a central occupational health clinic in a plant or in the district PHC centre. This permits accidental injuries to be recorded at the work sites where they occur, eliminating the need for an employee with a trivial injury to leave work and go to the clinic simply to record the occurrence. The occupational health clinic/ district PHC centre should receive and keep copies of these records and a record of all first aid treatment which it has itself provided. This record is called the acute care register.

First aid records are sometimes mandated by government regulation and are always important to the assessment of compensation claims. They also provide data vital to the assessment of the accident prevention programmes.

Accident investigations

There are three reasons why companies need to record and investigate occupational accidents:

- to identify the real causes of injury and illness, property damage and near-misses (accidents that might have happened)
- to develop effective methods of preventing future similar accidents
- to meet legislative requirements.

This is usually done by an expert on the occupational health and safety committee in the workplace or a labour inspector. These records must be kept systematically. The PHC workers must read the records thoroughly so that the knowledge on the findings can be applied.

Sickness certification

This recording is usually done by medical practitioners and kept by the management. The PHC workers must be supplied with abstracts of these records on a periodic basis. This will enable the PHC workers to relate any common sicknesses among workers to the findings of the health and safety inspection and the health education programme.

Personal health records

This set of records concerns the health status of each individual worker. It inevitably contains personal, privileged information which has special significance in law. Personal health records should be kept in their original handwritten form even if typed or computerized versions also exist.

A worker's personal health record should only reflect his/her health status insofar as it applies to the job. The content may therefore vary a great deal. The information which is usually found in the record includes:

- results of physical examinations
- X-ray and laboratory reports including ECG pulmonary function results and audiograms
- immunizations
- occupational and medical history
- participation in health programmes
- workers' compensation and medical insurance
- informed consent forms and authorizations for release of information
- documentation of refusals to undergo examination, testing and programme participation
- progress notes for rehabilitation
- consultant reports.

3. RECORD KEEPING

The best way to keep records is the simplest manner consistent with convenient, economical and efficient but controlled access. Dedicated forms are particularly useful but a trial in use should always be carried out before they are introduced into full service. If coding systems are used they should be compatible with existing, widely recognized systems, e.g. coding of illness and injury should be in accordance with the International Statistical Classification of Diseases and Related Health Problems of the World Health Organization.

It is recommended (in some countries it is mandated by law) that records be retained for at least 30 years. This is in the event of subsequent health problems being identified. These records must be transferred to a responsible recipient or a government agency if the employer, clinic or district centre goes out of business.

Computer storage permits automatic and very rapid retrieval of data in any combination and desired sequence. This is invaluable not only for worker health evaluation but for health programme operations and audit.

When considering the possibility of recording specific information or ceasing to record it, the following questions should be asked:

- Is this information required by regulation?
- Will this information be used?
- Will its use justify the cost of maintaining it?
- Can the information be obtained easily and with accuracy?
- Will the process of obtaining the information contravene or compromise legislated human rights?
- Are secure facilities available to store the record for the required retention period?

In general, a good occupational health record allows a reader to piece together a clear and coherent picture of workers' exposure on the job, health status, treatments and job assignments for a period of at least 30 years. Many associations between chronic disease and occupational exposures have been made using such records, and they are always important legal documents.

4. TASKS FOR TRAINEES

1. Visit the medical point at the workplace: check the records available and evaluate the quality of the recording.
2. Familiarize yourself with the forms used by the district health care centre to collect information on workers' health.
3. Review the national regulations regarding the recording system of occupational accidents and illnesses.
4. Design a form for collecting information for each type of proposed record in the module.
5. Familiarize yourself with the software used for recording occupational accidents and illnesses.
6. Familiarize yourself with the International Statistical Classification of Diseases and Related Health Problems of the World Health Organization.

MODULE 11

Occupational health in special areas

1. MINING

1.1 Objectives

- Be aware of and be able to describe the special problems of mines: physically, chemically, biologically and socially
- Learn how to set priorities in order to rank work-related actions and actions related to sanitary services
- Be familiar with typical situations and their problems: specifically, overloading, unhealthy conditions and dust exposure
- Learn where and to whom to refer for environmental monitoring consultations
- Have first-aid knowledge
- Know the health system, social welfare and health legislation
- Learn to use appropriate literature, checklists and data sheets
- Find ways to promote the health of the worker, to create awareness and to improve the working environment
- Learn accident reporting, accident investigation and simple accident prevention.

1.2 Introduction

Minerals and mineral products are the backbone of most industries. For many countries mining accounts for a significant proportion of the gross domestic product and for the bulk of foreign exchange earnings and foreign investment.

Mineworkers face a constantly changing combination of workplace circumstances, both daily and throughout the work shift. Some work in an atmosphere that is without natural light or ventilation. Despite the considerable efforts in many developing countries, the toll of death, injury and disease among mineworkers means that, in most countries, mining remains the most hazardous occupation when the number of people exposed to risk is taken into account.

1.3 Recognition, evaluation and simple control of harmful factors in mines

Physical hazards

(a) Noise

- definition
- effect on humans, e.g. deafness, hearing loss and psychological inconvenience
- prevention and control measures, e.g. instrument inspection, enclosing of source of noise, acoustic barriers for noisy tools and ear protection devices.

(b) Vibration

- definition and examples of vibrating instruments
- types of vibration: nuisance, segmental and whole body vibration, hand–arm vibration syndrome
- basis of prevention and control measures: repairing, improving or changing tools and machinery, use of personal protective devices and determining of work and rest time.

(c) Heat and humidity

- definition and heat sources
- effects on humans: fatigue, heat rashes, heat exhaustion, heat cramps
- prevention and control measures: use of cool and salty liquids, determining of work and rest time.

(d) Harmful radiation

- definition of ionizing radiation
- non-ionizing radiation effects on human organs, eyes and skin
- prevention and control measures: suitable clothing, personal protective equipment
- monitoring of external radiation by film dosimeters.

Chemical hazards

- definition and characteristics of dusts, fumes and gases
- dusts which cause pneumoconiosis, silicosis, silicotuberculosis
- chemicals which may mix with oxygen to cause explosion
- hazards of smoking among miners
- the effects of carbon dioxide, methane and hydrogen sulfide on health (carbon monoxide, nitrogen oxides)

- diesel exhaust gases: nitrogen oxides, fine particulates, sulfur oxides, polycyclic aromatic hydrocarbons
- prevention and control measures: wet processes, less dust production, personal protective equipment
- determining of work and rest times
- adequate ventilation for miners
- identification and monitoring of the contaminants by detection tubes
- biological hazards, occupational infections, tuberculosis.

Accidents

- causes of accidents in mines, e.g. fire, explosion
- unsafe mechanical and physical conditions
- unsafe acts
- unsafe personal factors
- risk assessment and appraising safety performance
- principles of accident prevention.

Ergonomics

- biomechanical background
- physiological background
- posture (sitting, standing)
- change of posture
- hand and arm postures
- movements
- lifting, carrying, pulling, pushing
- psychosocial (urbanization of rural areas, night shift, continuous work).

Health facilities in mines

- hygienic lavatory
- bath
- restaurant
- dressing-room
- safe drinking water
- waste and sewage management.

Health surveillance

- pre-employment examination, periodic examination
- tests for assessment of health impairment, e.g. forced vital capacity, forced expiratory volume, peak expiratory flow rate, blood pressure, body temperature, pulse rate, weight and height measurement.

1.4 Tasks for trainees

1. Visit the workplace, collect data about the workers, the work and work environment.
2. Set priorities based on observations, measurements, discussions, etc.
3. Offer advice on some simple prevention and control measures.
4. Refer problems to the referral system which cannot be solved by the community health care workers.
5. Educate workers on health and safety.
6. Apply first aid.

2. SMALL-SCALE INDUSTRY

2.1 Objectives

- Be aware of all health and safety-related hazards; learn how to define problems and special needs
- Describe the physical hazards and their control (see 1.3)
- Learn how to set priorities in order to rank actions
- Familiarize yourself with the typical problems associated with small-scale industry, e.g. long working hours, absence of holidays, lack of medical care and social insurance
- Know the health system, social welfare and legislation
- Have first aid knowledge
- Learn how to use appropriate literature, checklists and data sheets
- Find ways to promote the health of the worker, to create awareness and to improve the working environment.

2.2 Definition

There is no internationally agreed definition of a small-scale industry. Various parameters can be used to define it, e.g.

- number of employees

- amount of capital invested
- annual turnover or sales
- amount of raw materials used
- degree of mechanization and automation.

2.3 Working conditions

In most instances, working conditions in small-scale enterprises do not compare favourably with the larger and more affluent industries: low wages, poor working practices, lack of resources and a relatively hazardous work environment are the major factors affecting conditions in the industrial sector.

The hours of work are long. A 12-hour work shift and a 7-day week are common. Young children may be employed, even in heavy work. Machinery used may be obsolete in design and not properly maintained, increasing the possibility of accidents and exposure to hazards. Work sites may be situated in family dwellings, posing hazards not only to the workers but to the other family members as well, or in slum areas where overcrowding, heat, dust and poor ventilation are constant problems.

The standards of sanitation, hygiene, fire safety, protective equipment and first aid are generally low. Workers who suffer accidents may not be covered by compensation and workers may not even be paid on time. These conditions contribute to the generally poor working environment of these industries.

The typical worker in a small-scale enterprise in developing countries has a low level of education and comes from the lowest economic level of society. His/her nutritional level and general state of health are usually below ideal. This, combined with a work environment that is often hot, humid, overcrowded and where hazardous substances are often handled and processed without even elementary safety precautions, creates a situation with an overwhelming need for occupational health services.

2.4 Health conditions of workers

Factors affecting the health of workers

- state of the health of the worker before he/she started working
- working conditions prevailing in the workplace
- availability and accessibility of health and safety services at the workplace, including provisions for periodic medical examinations
- awareness of the worker and his/her manager of the hazards inherent in the work environment
- degree of enforcement and compliance with the legal provisions for occupational health and safety services.

Parameters in the assessment of the health conditions of workers

After finding these factors to be adverse and unfavourable in many small-scale factories, one can expect that the health of workers in these factories will be gravely affected. Various parameters have been used to assess workers' health:

- incidence of accidents and injuries
- symptoms related to occupations
- lung function tests
- audiometry
- urine and blood-lead examinations.

2.5 Methods of prevention and intervention

- Increase awareness in occupational health and safety among managers of small-scale industries as well as the workers themselves
- Find low-cost alternatives to health care delivery in the industrial sector
- Enact enforceable laws applicable to this problem where none exist as yet
- Provide incentives and motivation to comply with such laws and enforce them with penal provisions if necessary.

2.6 Tasks for trainees

1. Visit a workplace, collect data about workers, the work and the work environment.
2. Set priorities based on observations, measurements, discussions, etc.
3. Offer advice on some simple preventive and control measures.
4. Find out where to refer problems that cannot be solved by the community health worker.
5. Educate workers on health and safety.
6. Apply first aid.

3. AGRICULTURAL AND RURAL AREAS

3.1 Objectives

- Have an idea about general work conditions, environmental hazards and the main health problems in the agriculture and rural areas
- Know how to survey workplaces using simple methods
- Know how to decide to refer cases to the hospital or health centre if required

- Know how to recognize general health problems of workers whether or not they are work-related
- Know how to keep records and write reports.

3.2 General conditions and problems of life in rural areas

Demographic

- high proportion of children
- disproportionate low number of young adult males
- women and children participate to a great extent in the workforce.

Socioeconomic

- decrease in the agricultural land available with the continuous and progressive increase in the size of the population
- soil loss
- desertification
- migration of farmers.

Housing

- poor building materials
- lack of internal planning and sanitary principles
- potential for outbreak of fire and ignition sources
- livestock and poultry housed in the same dwelling as the farmer.

Water

- prevalence of waterborne diseases
- lack of rural water supply system.

Sewage and waste disposal

- dung mixed with garbage as manure
- poor bathing and washing facilities
- use of rivers and canals as disposal facilities.

Nutrition

- undernutrition due to overpopulation/land area
- poor nutritional habits
- micronutrient deficiency

- prevalence of endemic parasitic disease
- high metabolic requirements due to high metabolic expenditure in agricultural activities.

Education

- poor and inadequate education
- scarce teaching facilities
- high absentee rates of rural children
- lack of transportation facilities and bad weather.

Transportation and communication

- poor state of country roads and telephone services
- lack of marketing and medical care.

Clothing

- poor quality
- lack of personal protection equipment.

3.3 Characteristics of agricultural work

- type of work
- place of work
- the agricultural worker:
  - sharecropper
  - self-employed
  - paid-worker
  - mobile temporary worker.

3.4 Occupational hazards in agriculture

Physical hazards

- heat and humidity
- cold
- solar rays
- noise
- vibration (segmental or whole body).

Chemical hazards

- pesticides

- fertilizers
- animal feed additives.

Biological hazards

- zoonoses
- snakebites and insect and scorpion stings
- major communicable occupational diseases.

Dust hazards

- from soil, plants or animals
- may contain silica, fungal matter, animal matter, including insects and excreta, storage mites, grain dust and flour dust
- also may contain agricultural chemicals such as fertilizers and pesticides.

Ergonomic hazards

- heavy work
- repetitive tasks
- poor ergonomic design of tools and equipment
- incorrect working habits.

Occupational accidents and hazards

- The rate of accidental death in agriculture is one of the highest compared with other branches of production.
- The rate of serious as well as minor accidents is, on average, higher in agriculture than in all other occupations.
- Fatalities are caused most often by machines, especially tractors; animals, e.g. bulls, horses; falls; snakebites; fire and chemicals, e.g. pesticides.
- Non-fatal injuries are often caused by farm machines, hand tools, physical strain, animals, slipping and falls.
- Musculoskeletal disorders due to ergonomic hazards are common.

3.5 Prevention

- environmental control
- health education
- personal protection equipment.

3.6. Tasks for trainees

1. Assist in performing simple diagnostic tests for zoonotic diseases.
2. Assist laboratory technicians in stool and urine analysis for parasitic and endemic diseases.
3. Help in assessment of pesticides or their end products and metabolites in biological samples.
4. Recognize specific antidotes for pesticides and certain other agrochemicals.
5. Carry out first aid treatment for cases intoxicated by chemicals or pesticides.
6. Survey workplaces using simple methods and techniques.
7. Collect biological and environmental samples.
8. Identify possible and potential sources of injury in the agricultural workplace.
9. Recognize general health problems of agricultural workers and whether or not they are work-related.
10. Refer patients when necessary to the appropriate unit in the health service system.
11. Educate and advise workers on health and safety problems in agriculture.
12. Keep records of individual workers as well as records of working groups and surveys.
13. Associate with members of the occupational health team, report their observations and consult with them regarding control measures, the need for environmental and biological monitoring and the management of certain work-related or occupational health problems where applicable.
14. Assist in sanitation of the workplace with regard to water, waste, food, etc.
15. Detect and report on communicable, endemic, parasitic, occupational and work-related diseases in the workplace.
16. Maintain constant surveillance and checking of proper usage of personal protective equipment and measuring devices.
17. Participate with the managers and safety personnel in implementation of occupational health programmes.
18. Recognize early signs of poisoning and respond appropriately.
19. Check animals in the area daily in order to detect any diseased animals as early as possible.
20. Be capable of extracting an injured worker from agricultural equipment without further injury.
21. Study and consider the possibility of the human factor in any occupational accident.

22. Educate agricultural workers about the causes of heat stroke.

23. Spot cases of heat stroke and then confirm by taking body temperature and observing physical symptoms.

24. Know how to administer immediate first aid treatment for cases with heat stroke.

25. Help with the application of research projects according to established priorities using the simplest methods and techniques.

26. Make a health map of an area, highlighting risk areas and identifying risk factors in order to implement appropriate methods to control and solve problems.

MODULE 12

Occupational health for women and children

1. WORKING WOMEN

1.2 Objectives

- Know the impact of occupational hazards on working women's health
- Have appropriate training on primary health care for working women
- Appreciate the importance of the extension of maternal and child health as components of primary health care into the workplace
- Be acquainted with the reproductive health problems of working women in various occupations
- Know the preventive health measures that will have an impact on working women's health.

1.2 Occupational hazards

The number of women joining the workforce has steadily increased all over the world during the last few decades.

Throughout history, women in developing countries have always worked hard, not only as wives and mothers but also as workers in different sectors. Often encumbered with many children and weakened by excessive and frequent pregnancies, working women are subject to numerous risks e.g. fatigue, malnutrition, undue mental stress and exposure to various hazards at their workplaces.

Domestic work exposes women to many hazards which may undermine their health, e.g. accidents, burns, backache from bending, and chemical exposure from detergents, resulting in skin problems such as dermatitis.

In many countries, industrial expansion has occurred without sufficient protective measures for workers. Women are under special pressure since, in many instances, their jobs are considered by management to be of secondary importance and medical facilities are consequently inadequate.

Female workers differ from male workers in that they are generally physically smaller and are subject to specific stressful conditions peculiar to them, e.g. menstruation, pregnancy and lactation. PHC workers caring for working women should be aware of such conditions and their possible effects on work performance, and the effect of the work environment on the health of women at these times, e.g. there is a progressive increase in respiratory ventilation during pregnancy which may lead to increased uptake of inhaled chemicals from the air.

Psychosocial problems

Stress-related issues are encountered in nearly all jobs held by working women. The majority of women are still employed in low-paying jobs. For a single mother, a low wage and the home obligations of caring for children and doing the housework can be particularly serious causes of stress.

Stress at work can come from many sources, e.g.:

- office workers and assembly line workers in factories have demanding and repetitive jobs, which cause stress
- nurses often experience stress because their work is physically heavy and hectic.

Chemical agents

Due to the higher content of body fat in women than men, toxic substances such as organic solvents are retained more easily by women. Some studies suggest that exposure to organic solvents causes menstrual disturbances. Some metals, e.g. lead, can cause spontaneous abortion. Also some chemicals used in hospitals, e.g. ethylene oxide, are known to cause abortion.

Many women are engaged in agricultural activities which means they are exposed to pesticides and fertilizers. Some of the pesticides used in agriculture are suspected to cause reproductive damage in women. Women working in textile mills are exposed to organic dusts, e.g. cotton, which causes byssinosis.

Physical agents

Women working in the textile industry are exposed to noise, vibration and heat stress, particularly in the spinning and weaving sections. Noise causes vasoconstriction which may lead to low birth weight of babies. Studies have shown that women are more susceptible to whole body vibration and heat stress. Whole body vibration may damage the reproductive system. Radiation may also cause a problem. In addition poor lighting is not uncommon in many jobs leading to eye damage.

Biological agents

Nurses may be exposed to tuberculosis, hepatitis B, rubella virus, *Toxoplasma gondii*, AIDS, etc. Women employed in agriculture are exposed to snake bites, schistosoma, worm infestation, tetanus, etc.

Ergonomic problems

Bodily dimensions are an important consideration in physical work performance and machine design and operation. Many industrial and agricultural processes and machinery are designed for male workers making many machines difficult for female workers to operate.

1.3 Occupational health services for working women

Occupational health services should be established at all workplaces to ensure that the total health and safety needs of working women are met. Unfortunately, in many countries they are not accessible to large numbers of workers, especially in agriculture and small-scale industries. In these cases, PHC services should cater to the specific needs of working women.

Generally, the following points are of particular relevance to occupational health care programmes for working women.

Special health education

Health and safety inspectors, occupational health inspectors, employers and health policy makers should receive special training in health education for female workers. Education concerning health risks, including reproductive risks for men and women as well as potential effects on the foetus, and training in the safe use of chemicals, must be prioritized.

Regulations to safeguard working women

Regulations and standards applying to the entire labour force should be reviewed continuously for their relevance and adequacy to female workers. It is of special importance that safe working conditions are ensured for female workers, and pregnant workers in particular. It is important to prevent occupational hazards that are particularly harmful to women. Minimum standards should be set up for anthropometric parameters and physical capacity to be used in pre-employment examinations.

Environmental monitoring

The role of the industrial hygienist is to monitor the working environment for potential hazards. Environmental monitoring should be carried out regularly to identify problems which could affect the health of working women. Occupational hygiene standards should be recommended for various types of exposure, e.g. lead, solvents, pesticides, etc.

Pre-placement medical examination

These should be used to help in the proper placement of women in jobs appropriate to their physical, physiological and psychological capabilities.

Periodical medical examinations

Working women should undergo regular medical examination, especially those at particular risk.

Equipment design

The design of tools, machines and equipment should take into account the anatomical features and physiological capabilities of women.

Emphasis on underserved working women

PHC should focus on underserved working women, especially those employed in agriculture and small-scale industries. In addition, maternal and child health services should be available to such women.

Research and surveys

Research should be carried out on the effects on female workers of specific hazards associated with a wide variety of exposure conditions.

Women's rights

In addition to receiving information on occupational health and safety, working women should also be informed of their rights in connection with health, maternity and child care. It should also be ensured that women have sufficient rest in the last trimester of pregnancy and during breastfeeding.

Women's issues

In planning PHC services for working women it is essential to consider issues specific to them and to include the basic elements of maternity protection, family planning (the responsibility of men and women) and counselling.

1.4 Work exposure and pregnancy

The potential for reproductive hazards induced by workplace exposure is widely recognized. These include:

- infertility
- spontaneous abortion
- malformation
- perinatal mortality
- low birth weight
- developmental impairment
- childhood cancer.

Of these, spontaneous abortion and malformation in the offspring have attracted most attention in the occupational setting. For many outcomes it has been suspected that both female and male exposure may be the underlying cause. However, most studies and the best evidence relate outcome to the exposure of the woman during pregnancy.

1.5 Risk factors Identified in certain occupations and industries

Health care occupations may involve exposure to many kinds of reproductive toxins. Occupational factors which may carry a risk of spontaneous abortion include:

- anaesthetic gases

- ethylene oxide (sterilizing gases)
- antineoplastic agents
- organic solvents
- methylene chloride
- tetrachloroethylene
- aliphatic hydrocarbons
- contact with fur-bearing animals
- lifting heavy burdens
- X-rays.

Anaesthetic gases were the first gases suspected of causing harm to the foetus. Exposure has been effectively reduced in many countries. Recent studies have not found a significantly increased risk for spontaneous abortion and congenital malformation. Exposure to ethylene oxide, a gas used for sterilizing, increased the risk of spontaneous abortions. Handling of antineoplastic drugs in hospitals increases the risk of spontaneous abortion and malformation in the offspring.

Occupational factors appearing to carry a risk of malformations or functional defects:

(a) Malformation

- organic solvents
- antineoplastic agents
- ionizing radiation (X-rays, radioactive isotopes)

(b) Functional defect

- lead (decreased cognitive capacity)
- noise (hearing loss).

The harmful effects of ionizing radiation are known, and exposure in medical occupations is controlled. Health care work predisposes personnel to contagious diseases, among which HIV is a prominent problem.

According to several studies, exposure to organic solvents and/or laboratory work during pregnancy may increase the risk of spontaneous abortion and congenital malformation. Although exposure to solvents is common in numerous industries and occupations, it has been difficult to establish whether specific solvents, or their combinations, or solvents in general are responsible.

Exposure to heavy metals such as lead is suspected of causing reproductive toxicity. Quite low exposure during pregnancy may harm the cognitive development of the child.

Other occupational factors which should especially be controlled for during pregnancy include:

- heavy metals
- PCBs (polychlorinated biphenyls)
- pesticides
- carbon monoxide
- carcinogens.

Ingestion of food oil containing PCBs has caused disturbances in children, with some newborns of exposed mothers exhibiting small size, discoloration of skin and nails and premature eruption of teeth. This signals concern for occupational exposures too.

Carbon monoxide is a known asphyxiant for the foetus. Occupational exposure during pregnancy should be avoided; nevertheless, exposure occurs mostly via the mother smoking.

There are plenty of other chemicals which are suspected to be reproductive toxins and numerous industries are hazardous from the point of view of reproduction. In general, exposure to known carcinogenic and mutagenic agents should be avoided during pregnancy because they are potentially harmful to the foetus. Damage by these agents to the gametes is also possible prior to conception.

Congenital malformations and spontaneous abortions are the outcomes most widely investigated so far. Reported episodes of breast milk contamination have been mostly due to environmental pollution, but it should not be overlooked in occupations where exposure to substances that may accumulate in the body, e.g. PCBs and lead, is possible. Attention should also be paid to other exposures (e.g. solvents) when the mother is working during the breast feeding period.

The production and fabrication of plastics may include exposure to the monomers or to the thermodegradation products of the plastics. The textile industry has many possible reproductive toxins. Hairdressers use many chemicals of potential toxicity and flight stewardesses suffer more frequently from menstrual disorders.

The agricultural sector is often thought of as a safe workplace but it too can pose threats to women's health. In agriculture, little distinction is made between workplace environment and living environment, and farm workers are wholly dependent on the farmer for subsistence, leisure time and housing. Working women in agriculture face the risks of inadequate protection from toxic substances, such as pesticides, herbicides, dipping chemicals, paint, fertilizers and fuel. Farming also involves exposure to biological agents, such as microbes, microbial toxins and mycotoxins. Biological exposures in agriculture is significant and may become problematic with new biotechnology.

Physical and psychophysiological factors may play a role in reproductive hazards. The teratogenic and other harmful effects of ionizing radiation (e.g. X-rays, radioisotopes) on the foetus are known. This information is taken into account in many countries where the exposure of pregnant women is restricted by law. The effects of night work, heavy lifting, high temperatures and whole body vibration, as well as work with visual display terminals, need to be studied further.

1.6 Tasks for the trainees

1. Describe the main occupations in which women in your area work.
2. Characterize the adverse health risks which working women are exposed to in these occupations.
3. List the most important PHC services in your facility which may be beneficial to working women.
4. Prioritize the health education topics you recommend to educate working women within certain occupations.

2. CHILD LABOUR

2.1 Objectives

- Know the impact of occupational hazards on the growth of working children
- Be aware of the consequences of child labour on the community in general
- Know if a child's injury or illness is work-related
- Know how to teach health education to working children, their employers, parents, teachers and the community.

2.2 Definitions and basic concepts

Child labour is defined as the paid employment of children younger than 18 years of age.[1] The legal minimum age limits for work differ from country to country and from activity to activity. Many countries make a distinction between light and hazardous work with the minimum age for the former generally being 12, for the latter usually varying between 16 and 18. The International Labour Organisation Minimum Age Convention (No. 138, 1973) also broadly adopts this approach, allowing light work at age 12 or 13 but hazardous work not before 18. Nevertheless, the ILO also establishes a general minimum age of 15 years, providing 15 is not less than the age of completion of compulsory schooling.

Child labour can be broken down into seven main types, none of which is unique to any country or region of the world:

- domestic service
- forced and bonded labour
- commercial sexual exploitation
- industrial and plantation work
- street work
- work for the family
- girls' work.

---

[1] Landrigan PJ et al. Child labor. *Pediatric annals,* 1995, 24:657–62.

Most children who work do not have the power of free choice. Child labour is associated with poverty, inadequate educational opportunities and failure to enforce relevant laws and standards. Particularly severe child abuses have been documented in so-called free enterprise zones, i.e. special industrial areas where labour and environmental laws are not enforced.

Illegal child labour is widespread and hundreds of millions of children all over the world are employed under unlawful conditions. According to the ILO at least 200 million children under the age of 14 are employed worldwide.

Illegal employment of children occurs in all industrial sectors and often under sweatshop conditions. A sweatshop is defined as an establishment that violates wage, hour and child labour laws as well as the laws protecting occupational safety and health.[2] Health and safety conditions in sweatshops are often dangerous.

A decade ago, UNICEF determined that child labour was exploitative if it involved:

- full-time work at too early an age
- too many hours spent working
- work that exerts undue physical, social or psychological stress
- work and life on the streets in bad conditions
- inadequate pay
- too much responsibility
- work that hampers access to education
- work that undermines children's dignity and self-esteem, such as slavery or bonded labour and sexual exploitation
- work that is detrimental to full social and psychological development.

2.3 Why children work

- Poverty (poor economic and social environment) has always been the reason that children work. Children of landless peasants or of underemployed parents are at greater risk since, by working, they can contribute substantially to the family income.
- Children working in exploitative, harmful conditions often come from disadvantaged and economically vulnerable population groups, including female-headed households, lower castes, indigenous or tribal people and migrant families.
- Children in traditional societies, usually in their closely knit family situations, are sent to work by parents who consider work an essential part of development and socialization.

---

[2] US General Accounting Office. *Sweatshops and child labour violations: a growing problem in the United States.* Washington DC, Government Printing Office, 1989.

- Child labour is also generated by deficiencies in educational systems. Schools may not represent a possible way to get out of poverty. Given the low quality and implied costs of the education services available to the poor, many parents, having themselves worked as children, tend to consider an early entry into the labour market, rather than schooling, as the best way to equip their children with skills useful for their future as adults.

2.4 Work and health of a child

Many of those who support the argument that children have to work to survive in some situations strongly believe that work has something to do with promotion of a child's health. Their reasoning: when a child earns an income, such income will be used to buy food, clothing and, at times, shelter. And, such a child would be protected from all forms of trouble, e.g. roaming the streets. In a situation where the child is the only wage earner, the child's family is supposed to benefit and be able to support other family members more effectively. They reason that work in this context may enhance both the child's and the family's capability towards good health.[3]

Consequences of hazardous work for children's health

While the above may be true in an ideal situation, unfortunately studies show that many children are deprived of opportunities for optimal education, social intervention and physical growth. A review of the literature and reports reveal the following as consequences of hazardous work for children's health:

- working children have poorer health status than non-working children
- malnutrition is quite common among working children
- impaired psychosocial development of working children has a long-term effect
- accidents among working children are frequent
- working children are not ergonomically compatible with the equipment and tools provided by the workplace
- workplaces provide ample opportunity for acute and chronic poisonings.

Factors contributing to dangers to children

Children are employed in a variety of occupations where dangers are not as apparent. These dangers could affect a child's health and safety. Factors that contribute to dangers for children include:

- certain work arrangements (e.g. separation from families, living inside workplaces)
- exposure to specific hazardous processes and tasks (e.g. lifting heavy weights, working underground)

---

[3] Gust-Estrella DP. Case studies in hazardous child labour. *International child health: a digest for current information*. Geneva, UNICEF, 1993.

- exposure to hazardous materials such as chemicals (both in industry and agriculture), dangerous machinery and dangerous tools
- exposure to hazards in the physical environment, including noise levels, radiation exposure, extreme temperature of the working environment,
- poor lighting, chemical and biological hazardous agents, working posture and dust
- general working conditions, including working hours, wages, number of work days (per week or per month), amount of rest and recreation
- absence of health and safety measures including personal protective equipment, welfare and health facilities, ergonomic considerations, first aid, regular medical facilities, a system of referrals
- absence of environmental safety measures (such as safe water supplies and toilets) and poor access to food
- lack of legislative protection (in the informal sector, in domestic work, etc.)
- inadequate supervision
- inadequate labour inspection services.

2.5 Risks of child labour

Risks to development

Work that is harmless to adults can be extremely harmful to children. Among the aspects of a child's development that can be endangered by work are:

- Physical development: including overall health, coordination, strength, vision and hearing. Carrying heavy loads or sitting for long periods in unnatural positions can permanently disable growing bodies. Hard physical labour over a period of years can stunt children's physical stature by up to 30 per cent of their biological potential, as they expend stores of stamina that should last into adulthood.[4]
- Cognitive development: including literacy, numeracy and the acquisition of knowledge necessary to a normal life.
- Emotional development: including adequate self-esteem, feeling love and acceptance.
- Social and moral development: including a sense of group identity, the ability to cooperate with others and the capacity to distinguish right from wrong. Child labour also interferes with play, which is important for normal development; relaxation and freedom from fatigue are necessary for children to grow and learn.

[4] Allsebrook A, Swift A. *Broken promise*. London, Hodder and Stoughton, 1989:91.

Risks of injury and death

The risk of injury is almost 10 times greater among children employed under illegal conditions than among those working in compliance with the laws. Examples are:

- lacerations
- amputations and crush injuries from machinery
- motor vehicle accidents involving farm vehicles on public roads
- suffocation in grain elevators and silos
- blunt trauma from large animals, e.g. as a result of being kicked by a cow.

Risks of occupational diseases and poisonings

Children are particularly vulnerable to certain problems and diseases and are at greater risk in their occupational environment due to their lack of experience.

The occupational environment contains a variety of chemical, physical, biological and ergonomic hazards, e.g. exposure to certain dusts can lead to chronic lung disease. Also, working children may experience a variety of toxic exposures at work, e.g. formaldehyde and dyes in the garment industry, solvents in paint shops, pesticides in agriculture, asbestos in building abatement and benzene in petrol filling stations. Young people may not have information or knowledge about these hazards and sometimes, even if they have the information, they may not be willing or able to take the necessary steps to protect themselves.

Risks to education

Education helps a child develop cognitively, emotionally and socially. Interference with school performance is a serious consequence of child labour. Working children risk having too little time for their homework and being overtired on school days. The social environment of work sometimes undermines the value children place on education.

Lack of education condemns children to the worst employment prospects and, in turn, the sheer pressure of survival will result in these children joining the low wage earners.

2.6 Prevention and protection measures

Any effective measure to protect working children from workplace hazards must begin by highlighting both the children and the dangers they face. Recognition of the situation is the first vital step. Next, the presence of strong and determined political will is needed in order to formulate policies and realistic programmes towards the effective termination of the practice of child labour.

However, certain health problems of legally working children can be avoided in the first place if there is appropriate job placement, i.e. a matching of the needs of the job with the abilities and potential of the individual. A pre-placement examination can also avert certain difficulties, e.g. when prospective employees are allergic to various substances.

Working young people should be protected, as far as possible, from dangerous working environments, e.g. areas where there is fast-moving machinery.

Where there are toxic substances, such as lead dust, the monitoring of the concentrations of these substances in the air, as well as in blood and urine, becomes important. Record keeping can be used to indicate sickness and absenteeism that might point to specific difficulties.

Health promotion in workplaces should involve education on the broader issues of accident prevention, nutrition, healthy lifestyles, etc.

The early treatment and subsequent rehabilitation of young people with injuries and illnesses, whether physical or psychological, should be ensured.

However, prevention of injury and illness among working children, including illegal types of work, requires a coordinated series of actions in several areas:

- Better education of children, parents, teachers, physicians and the business community on the hazards of child labour.
- Better methods of diagnosis: occupational history should be routine in the evaluation of acute trauma and should be used when assessing children with potential work-related conditions, such as repetitive motion injury or organophosphate poisoning.
- Development of better data to define the extent and patterns of child labour: better systems are needed to monitor the working patterns (legal and illegal) of children and young adolescents: their number, age, employment patterns by industry and occupation and the number of hours and days worked. This information would help focus enforcement efforts and track trends in childhood employment.
- Development of better data on work-related injuries in children and adolescents: employers should be legally required to report all injuries of working children and adolescents to the health and labour authorities.
- Strengthening and improving legislation and enforcement measures of child labour laws.
- Ensuring that the main places where children work and the worst forms of child labour are encompassed by national legislation.
- Ensuring that national labour and education laws are consistent so as to eliminate the discrepancies which may exist between the minimum age required by the law to work and the minimum age permitted to leave school.
- Improving schooling for the poor: the single most effective way to stem the flow of school-age children into abusive forms of employment or work is to extend and improve schooling so that it will attract and retain them.

2.7 Tasks for the trainees

1. Describe the main types of employment and occupations in which children in your area work.

2. Characterize the knowledge and attitudes of their families towards the problem of child labour in general.

3. Review the available data on working children at the national level and define the shortcomings. Discuss ways of broadening the sources and strengthening the validity of data on child labour.

4. Design an occupational history questionnaire for approaching children's injuries and illnesses suspected to be work-related.

5. Discuss the national legislation and standards related to child labour. Suggest ways to improve their quality and enforcement.

6. Discuss the prevention and protection measures that can be applied to certain occupations where children may be working legally.

7. Discuss the role that schools may play in confronting the child labour problem; also the role of the community in general.

FURTHER READING

Centers for Disease Control and Prevention, National Center for Occupational Safety and Health, *Pocket guide to chemical hazards*. Itasca, Illinois, National Safety Council Press, 2000.

Children at work: special health risks. Report of a WHO Study Group. Geneva, World Health Organization, 1987 (Technical Report Series No. 756).

Economically active population 1950–2010. 4th ed. on diskette. Geneva, International Labour Organisation, 1996.

Harrington JM et al. *Occupational health*, 4th ed. Oxford, Blackwell Science, 1998.

Health promotion for working populations. Report of a WHO Expert Committee, Geneva, World Health Organization, 1988 (Technical Report Series No. 765).

Jeyaratnam J, Koh D. *Textbook of occupational medicine practice*. Singapore, World Scientific Publishing, 1996.

Jeyaratnam J. *Occupational health in developing countries*. Oxford, Oxford Medical Publications, 1992.

Kitunga LJ. Working women. *East African newsletter on occupational health and safety,* 1989, 2:8–10.

LaDou J. *Occupational medicine*. New York, Appleton & Lange, 1990.

Last PA. Health protection and promotion. Women's health. In: Stellman JM, ed. *Encyclopaedia of occupational health and safety*, 4th ed. Geneva, International Labour Organisation, 1998.

Levy BS, Wegman DH. *Occupational health, recognizing and preventing work-related disease*, 2nd ed. New York, Little, Brown & Company, 1988.

McCunney RJ, Rountree PP. *Occupational and environmental medicine. Self-assessment review.* Philadelphia, Lippincott Williams & Wilkins, 1998.

Occupational health for all. In: *Biological monitoring of chemical exposure in the workplace*, Vol. 2, Geneva, World Health Organization, 1996.

Plog BA, Niland J, Quinlan PJ. *Fundamentals of industrial hygiene*, 4th ed. Itasca, Illinois, National Safety Council Press, 1996.

Rom WN, ed. *Environmental and occupational medicine*, 3rd ed. Philadelphia, Lippincott Williams & Wilkins, 1998.

World of work. The magazine of the ILO. Geneva, International Labour Organisation, 1996, 16.

World of work. The magazine of the ILO. Geneva, International Labour Organisation, 1997, 19.

World of work. The magazine of the ILO. Geneva, International Labour Organisation, 1997, 20.

Young people's health: a challenge for society. Report of a WHO Study Group on young people and "Health for All by the Year 2000". Geneva, World Health Organization, 1986 (Technical Report Series No. 731).