全国高等学校教材
供预防医学专业双语教学用

职业卫生与职业医学

主编 牛 侨

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PEOPLE'S MEDICAL PUBLISHING HOUSE

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National University Textbook
For Bilingual Course on Discipline of Preventive Medicine

Occupational Health & Occupational Medicine

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前 言

职业卫生与职业医学是预防医学领域的主干学科，其中职业医学部分也属临床学科，因此是预防医学与临床医学相结合的一门重要学科，对于保护职业人群健康，预防、控制和治疗职业病，保证可持续发展，促进社会和谐起着十分重大的作用，而且这种作用是其他学科不能替代的。我国正处于高速发展阶段，不可避免地产生各种各样的职业卫生问题，这其中有传统的职业卫生问题，也有随着新材料、新工艺而带来的新问题。所有这些问题的解决都需要合格的职业卫生和职业医学人才，而这些人才的培养都需要职业卫生与职业医学这门学科。

作为一个学科，职业卫生与职业医学在迅猛发展，只靠国内的教科书难以满足学生的需求，完全引进国外的教科书不符合我们的国情，对学生亦不一定适用。为了让学生了解国外职业卫生与职业医学的内容，同时又能培养学生学习本学科的专业词汇和内容，编写一本有关职业卫生与职业医学的双语教材显得十分重要和迫切。因此，我们组织全国10所具有较强师资力量的公共卫生学院的教师编写了这本《职业卫生与职业医学》双语教材，目的是满足国内五年制预防医学专业学生教学的需求。

到目前为止，这是国内第一本《职业卫生与职业医学》双语教材，因此没有先例可循。在本教材的编写过程中，我们遵循了卫生部规划教材的总体原则和基本要求，其内容和体系尽量贴近现有国内中文教材。参加本书编写的专家都是各学校具有博士学位的中青年骨干教师，大部分有国外留学的经历。他们的深厚的专业功底、严谨学风和团队精神保证了本教材的完成，同时在专业方面也给了我很大的促进。在此，我对他们的辛勤付出表示衷心的感谢，也深切感谢他们对我的信任、理解和支持。在本书的组稿、审稿、校对过程中，编写秘书杨瑾博士付出了辛勤的劳动，在此谨表谢意。

本书的编写得到了山西医科大学领导的大力支持，在此谨表示衷心的谢意。

由于该书是国内《职业卫生与职业医学》双语教材的首次尝试，编写方式也是首次尝试，加之主编水平有限，书稿中难免有内容不合适、失察或不尽如人意、甚至谬误之处，诚恳地希望职业卫生与职业医学界各位专家和同道、各校使用本教材的老师和同学们提出宝贵意见。

牛 侨

2011 年 8 月于太原

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The following represents a systematic public health approach to preventing occupational diseases and injuries.

Anticipation

Anticipation is the cornerstone of the public health approach to controlling occupational disease and injury. It is a concept that merges two important elements: prediction and action. According to the New Oxford American Dictionary (2001), to anticipate is "...to expect or predict; ...to take action in order to be prepared." In occupational health, anticipation involves an active expectation that hazards will occur. Thus, occupational health and safety professional have critical tasks to perform. They must (1) acquire the knowledge necessary to prevent disease and injury, (2) use it to anticipate problems, and (3) intervene to prevent their occurrence and reoccurrence. Occupational disease and injury are not an inevitable part of work.

Anticipation can take many forms. These include factoring worker health and safety into the design of work, workplaces, and work processes and practices and into the selection of safest/least hazardous materials and methods. Training and educating workers, managers, and health and safety employees about aspects of workplace technologies are also keys. Preplacement and return-to-work medical examinations can play a role in anticipation and prevention. When coupled with the necessary and specific information about the workplace and demands of a job, an understanding of a worker's abilities and limitations can help predict and prevent future problems. Other aspects of anticipation include promoting good labor-management relations, forming active worksite health and safety committees, and eliminating payment and incentive mechanisms that encourage supervisors and workers to cut corners. Worksite-specific policies as well as overarching public policies and regulations can stimulate and support these efforts.

When employers and other decision-makers create or modify work-places, they routinely anticipate and consider many factors, such as the price and accessibility of materials, the availability and training of the workforce, the most appropriate and efficient work methods and technologies, proximity to markets, and transportation. Health and safety hazards must find their place among these factors. Decision-makers should incorporate hazard control into their planning and decision-making processes. Then, steps to protect worker health and safety can be taken early in the design phase, before commitments are made that will be difficult and expensive to change-literally before they are cast in concrete.

Hazard Inventory

A comprehensive hazards inventory can be a useful tool in the anticipation and recognition of risk. Hazards can be inventoried by their form and route of exposure (Table 1–1) and can be evaluated with estimates or measurements of exposure combined with an assessment of potential harmful effects. This hazards inventory involves a systematic enumeration of physical, ergonomic, chemical, biological, and psychosocial hazards present in the workplace;

the routes of exposures; and an estimation of the frequency and intensity of potential exposure.

Table 1–1. Hazards Inventory

Ⅰ. Physical Hazards	2. Gases and vapors
A. Noise and vibration	B. Skin Absorption
B. Extremes of heat and cold	C. Ingestion
C. Radiation	D. Other routes
D. Barometric pressure	Ⅳ. Biological Hazards
E. other	A. Infectious microorganisms
Ⅱ. Ergonomic	B. Chemical hazards of biological origin
A. Repetitive motion	C. Animals and plants
B. Excessive force	Ⅴ. Psychosocial Hazards
C. Awkward posture	A. Work load; speed and hours of work
D. Other and aggravating conditions	B. Control over work
Ⅲ. Chemical Hazards	C. Social isolation
A. Inhalation	D. Work organization
1. Particulate matter	E. Abusive social environment

Physical hazards are different forms of energy. These include noise, vibration, ionizing and non-ionizing radiation, extremes of temperature and of barometric pressure, and rapid change in barometric pressure. In general, risk of injury increases with the energy level. Specific hazards are described in more detail in related chapters (see, for example, Hearing Loss, Noise-Induced; Radiation, Ionizing and Nonionizing; Hyperbaric Injury; Injuries, Fatal and Nonfatal; and Heat Stress). Circumstances that can result in acute traumatic injury, such as working at heights or on busy highways, are also physical hazards.

Ergonomic hazards are physical motions or positions that may cause acute or chronic injury. These include repetitive or awkward motion, excessive force, flexion or extension, or awkward or static posture. Effects of these hazards are aggravated by stress, temperature extremes, work organization, and other environmental factors.

Chemical hazards are classified as solids, liquids, or gases that most commonly enter the body by inhalation, ingestion, or absorption through the skin. Harmful effects depend on the nature of substances, the magnitude of exposure and dose, and the duration of exposure. Inhalation is the most common route of entry for chemical hazards, although chemicals may be ingested if they contaminate food, drink, or smoking materials or are coughed up and swallowed. Evaluating the potential health effects of airborne particles (dusts, mists, and fumes) requires knowledge of their identity and concentration, as well as information about their size (diameter). Particle diameter determines the site of their deposition in the lung which, in turn, determines the site of injury and whether the particle is absorbed systemically (sees

Box). Some explosive and flammable gases and vapors, organic particles, such as coal, grain, and sugar, and some metal aerosols, such as magnesium and aluminum, may also create risk of fire or explosion.

Biological hazards include infectious microorganisms, plant or animal toxins, and animals. Microorganisms may (a) cause frank disease, such as viral hepatitis or Lyme disease; (b) cause allergic reactions, such as those associated with molds; (c) deplete oxygen; or (d) produce toxic gases. Plants may produce toxins. Animals may attack and transmit infections to zookeepers, veterinarians, postal delivery workers, and other workers. These hazards are described in Part Ⅱ chapters on such topics as Human Immunodeficiency Virus (HIV) Infection; Tuberculosis; Hepatitis, Viral; and Zoonoses.

Psychosocial hazards result from a complex interplay of job demands, skills, decision-making latitude, and personal control of work, work organization, and social interactions.

BOX •••

Aerosols

- *Particles less than 5–10μm in diameter are called respirable. They are likely deposited in the alveoli and terminal brochcioles where gas exchange occurs.*
- *The relative solubility of aerosols, gases, and vapors also affects the site of deposition and injury or absorption, with the more highly water soluble likely to be absorbed in the upper airways.*
- *Respirable particles are more likely to be retained and absorbed than large particles and thus cause lung injury or systemic disease.*
- *Repetitive deposition of aerosols in the airways may result in chronic airway irritation.*
- *Extremely small particles may behave differently and may be absorbed and distributed systemically.*

Recognition

Hazard inventories coupled with knowledge and experience related to the workplace, work processes, and workforce are valuable tools for anticipating health and safety risks and implementing prevention strategies. However, ongoing monitoring of hazards and of the health of workers is needed to identify and respond to changing or unanticipated risks to health and safety in both stable and unstable work environments. Surveillance, or tracking, of workplace hazards and worker health can help in the recognition of risk and adverse effects.

Surveillance

Surveillance, as defined in the Dictionary of Epidemiology, is "the ongoing scrutiny [of the occurrence of disease and injury], generally using methods distinguished by their

practicality, uniformity, and frequently their rapidity, rather than by complete accuracy. Its main purpose is to detect changes in trends or distributions in order to initiate investigative or control measures." Surveillance is a fundamental part of public health practice. A surveillance system for occupational disease and injury control should (a) acquire information about hazardous exposures and diseases and injuries (outcomes), (b) analyze this information, and (c) disseminate and interpret it to those who need it. Mere information-gathering is not sufficient; the point of surveillance is to prevent disease and injury, not only to document its occurrence. Thus, a surveillance system must be linked with the capability to investigate further and to intervene to prevent disease or injury.

Surveillance strategies differ for acute and chronic health outcomes. For acute conditions, in which the time between exposure and outcome is short and/or the relationship of outcome to work is apparent, exposures and conditions that have caused disease or injury are more easily identified and controlled. Specific causes are more difficult to identify for chronic conditions, which are often multifactorial in nature but may result from long-term and/or low-level exposure or appear after many years (latency). The exposures that caused the disease may have changed or disappeared by the time the disease becomes clinically apparent. Even if the exposures that caused the disease remain in the workplace, the disease may not occur until late—well after the worker leaves the workplace for another job or to retire. Moreover, for irreversible conditions, control of hazards is effective at preventing disease or injury only prospectively and cannot correct harm that has already occurred. Therefore, surveillance for some chronic or long-latency health effects should persist even after hazards are controlled.

Identification of hazards that cause chronic effects often requires more knowledge than is available from the literature or from professional sources knowledgeable of problems in other settings may establish the need for controls. It is not prudent to wait for the development of chronic disease in any single workplace before reducing exposure that has caused problems elsewhere.

For both acute and chronic conditions, surveillance of exposures and of outcomes can be practiced both inside and outside specific workplaces. At the level of individual workplaces, surveillance involves systematic workplace inspections, measurement and evaluation of exposure, examination of workers, recordkeeping, and reporting of health effects and exposures. Surveillance at the workplace is thus an essential ingredient for managing a disease and injury prevention program. When practice in settings apart from individual workplaces—for example, at local, state, or national agencies, hospitals, or disease or injury registries—surveillance can involve acquiring and analyzing data from a wide variety of sources, including employer reports, workers' compensation claims, hospital records, police reports, disease registries, and poison control centers. Regardless of the source of surveillance data, however, most information arises from workplaces, and intervention must eventually focus on workers, employers, and workplaces.

Hazard Surveillance

Workplace inspections should occur regularly to identify new problems and ensure that existing controls and prevention strategies are adequate and maintained. They also should be conducted (a) immediately after injuries, accidents, or near-misses occur to identify manifest and root causes; and (b) when someone on the job suspects a problem and requests an inspection. Inspections may be required by statute or regulation, by some insurance carriers, or by a labor-management contract.

Inspections can be conducted by health and safety committees, workers at the job site, health and safety professionals, engineers, or inspectors from outside the workplace, such as those from regulatory agencies, insurance carriers, parent corporate offices, or labor unions. Workers have regular and sustained experience with the workplace and are essential witnesses to circumstances surrounding specific incidents. Both employers and employees should be represented to ensure a balanced and full assessment of the hazards. Safety engineers bring needed expertise and experience to any inspection. Inspectors, insurance agents, or experts from parent corporations or unions, bring fresh perspectives and knowledge of pertinent regulations and guidelines. They may also bring needed incentives in the form of citations, changes in insurance rates, and other penalties or rewards.

Regardless of the reason prompting them, inspections are an important source of data for use in later analysis. Therefore, information should be documented in a consistent form. Periodic inspections not related to particular incidents should be systematic and custom-made for each workplace or industry. Checklists and a plan to visit every job site are useful. A walkthrough survey should follow the flow of work from start to finish, accounting for uses, storage, waste, byproducts, disposal of all materials, and maintenance operations. Records of prior inspections, committee meetings and actions, and injuries should be available to monitor performance. The frequency of inspections depends on the degree of hazard. In the high-hazard underground coal mining industry, for example, certain inspections are required by statute prior to each work shift.

Employers are legally required to record work-related injuries that result in medical treatment, time away from work, and restricted activity. These records may be obtained by the Occupational Safety and Health Administration (OSHA) or by workers and their representatives. At a specific workplace, these records are useful surveillance tools. Although intended to cover both diseases and injuries, these records are inherently more likely to reflect acute conditions, such as traumatic injuries, and certain acute diseases, such as contact dermatitis and acute poisoning, than chronic conditions. Under the Mine Safety and Health Administration (MSHA), records of injuries and accidents are required to be reported (not merely recorded) and are available from MSHA.

Monitoring and measuring some occupational hazards are required by law. Employers under OSHA jurisdiction are required to maintain exposure records and make them available to OSHA or to workers or their representatives. When analyzed collectively, surveillance

data can be used to identify potential hazards and, in some instances, to estimate exposure for individuals or populations over the period the regulations have been in effect. Exposure monitoring data for the mining industry are available from MSHA.

Medical (Health) **Surveillance** (Biological Monitoring of Effects)

The purpose of medical surveillance is to promote prevention by identifying the distribution and trends in the occurrence of disease and injury in populations. Outcome measures may range from individual signs and symptoms to well-defined diseases. Most often, medical surveillance results in secondary rather than primary prevention, because it can only identify individuals already affected by occupational exposure. When combined with hazard surveillance, however, analysis of medical surveillance data can complement primary prevention efforts by also identifying hazards. Surveillance is distinguished from screening (described below) by its concern with a target population; screening is primarily concerned with individuals.

Medical surveillance may be conducted at specific workplaces or in community settings. Employer medical departments usually have easy access to workers and to workplaces and thus are well situated to detect acute conditions, monitor active workers' health regularly, link medical with exposure data, and implement programs for the early detection and prevention of occupational conditions. Conditions caused by multiple exposures at different workplaces and chronic conditions that may not appear until after retirements are harder to detect by workplace-based surveillance programs. Moreover, workplace-based medical departments serve only a small minority of the working population—usually those situated in large or exceptionally high-risk workplaces.

Surveillance efforts that are based on data from the community, clinical settings, and registries complement workplace surveillance programs. Such efforts may be designed and implemented by government agencies, hospitals, clinics, or they may be based on networks of health care providers. For example, the Sentinel Event Notification System for Occupational Risk (SENSOR) program developed by the National Institute for Occupational Safety and Health (NIOSH) and implemented by some states is a small-scale model of disease surveillance for selected disease outcomes with well-defined clinical features. The states may use several data sources, including case reports from a select group of health care providers, hospital discharge data, and workers' compensation data. A state agency collects and analyzes the information and reports and follows up to help activate preventive measures.

Medical surveillance may be active, in which populations of workers are selected, recruited, and examined, or it may be passive, relying on existing data collected at medical facilities for other reasons. Passive surveillance usually detects only symptomatic disease and cannot be relied on to uncover conditions earlier in their natural history. It also requires that health professional be also to recognize the effects of occupational exposures in individuals in clinical settings. Because many occupational and nonoccupational diseases resemble each other and because occupational diseases are only suspected when an exposure history is

obtained, passive surveillance cannot be relied on to detect many work-related diseases without a complementary effort to assess occupational exposures.

Active surveillance for work-related conditions requires assessment of exposure prior to conducting surveillance in order to define and select the appropriate population. Workers selected for active surveillance are usually at high risk for disease or injury. Selection criteria include assessment of current or past exposure based on measurements (if possible), employment history, or similar parameters. Because health effects depend on the identity of hazards, exposure assessment is also required prior to selecting medical testing procedures. For example, workers exposed to lead should receive regular laboratory tests for blood lead levels; workers exposed to silica, chest x-rays; and workers exposed to noise, audiometric examinations.

The occupational contribution to illness often cannot be recognized when individuals are considered in isolation from similarly exposed workers. Thus, results of surveillance should be analyzed in populations classified by exposure. Basic epidemiological methods are used to analyze such data, so that when aggregate findings are linked with assessment of occupational exposure, the results can be used to identify, evaluate, and control hazards.

Medical Screening

The purpose of medical screening is the early detection of disease or conditions for which treatment can successfully affect morbidity or mortality. Screening is a form of secondary prevention. Medical screening programs at work can provide the data for ongoing population health surveillance efforts. Screening usually consists of performing physical examinations and specific tests for the purpose of detecting disease at an early treatable or remediable stage. Ideally, screening should be designed and administered within an overall program that identified people at risk, educates and informs them about the screening program, implements the screening program, and appropriately follows up with diagnostic tests on those who screen positive and with treatment for those who have disease.

Various types of screening tests are relevant to occupational health, ranging from pulmonary function tests that help detect respiratory impairment associated with work-related lung disease to tests and procedures for the early detection of various types of cancer. Important considerations in a screening program include the sensitivity of a test (the degree to which it correctly identifies those with the disease or condition), the specificity of a test (the degree to which it correctly identifies those without the disease or condition), and predictive value positive (the likelihood that a person who screens positive for a disease or condition actually have that disease or condition). There is often a trade-off between sensitivity and specificity in choosing among various screening tests and in determining a cut-off for abnormality in a given screening test; that is, a highly sensitive screening test is likely to be less specific, and a highly specific screening test is likely to be less sensitive. While screening is considered secondary prevention, it can indirectly identify hazardous workplace situations and lead to effective primary prevention.