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Occupational and environmental medicine in the United States

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Abstract The history and the current status of occupational and environmental medicine (OEM) research, educational resources, clinical practice patterns, and regulatory framework in the United States are reviewed. Current or anticipated changes in health-care financing, clinical practice patterns, occupational safety and health regulations and enforcement, and funding for research and medical education at the national level are already having an impact on OEM activities in this country.

Key words Occupational health services · Graduate medical education · Undergraduate medical education · Occupational medicine · Physician's practice pattern · United States

Introduction

Academia, labor, industry, and governmental agencies have played important and influential roles in the development of practically every aspect of the field of occupational and environmental medicine (OEM) in the United States. We present herein a brief historical perspective of OEM in the United States and a description of available resources for research, training, and clinical services as well as of current practice patterns and the regulatory framework in which they take place. The potential impact of recent and anticipated changes in the provision of health services in this country is also discussed.

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Background

Although industrial activities began in the early 1600s in the United States, it was not until the nineteenth century that manufacturing became the predominant economic activity in this country. Industrial development occurred earlier in some European countries, as did occupational health activities and regulations [7]. Massachusetts introduced the first occupational safety regulations in the second half of the nineteenth century. Unions began sponsoring sick-benefit programs in the 1870s, and the first (and still existing) large-scale union-based health center (established by the International Ladies and Garment Workers Union in New York City) was opened in 1914. The first industry-sponsored general health-care facilities were created in 1882. In 1910 the first specifically dedicated occupational health clinic was established at Cornell Medical School in New York City.

The establishment of individual state Workers' Compensation programs began in 1911 (in Wisconsin, followed by seven other states that same year) but their nationwide availability was not complete until 1948. In 1914 the Office of Industrial Hygiene and Sanitation was created with funds from the United States Public Health Service. The pioneering work of Alice Hamilton was critical in establishing industrial medicine as an important scientific discipline [8]. The University of Pittsburgh first provided specialized training for individuals, leading to the establishment of a doctoral diploma in industrial medicine in 1950. In 1955 the American Medical Association approved the subspecialty certification in Occupational Medicine by the American Board of Preventive Medicine. In 1960 the American Board of Industrial Hygiene was created and certification of industrial hygienists began [11].

The definitive and major legislative measure that led to a comprehensive regulatory framework for occupational health and greatly expanded the field of occupational health was provided by the passage of the

Occupational Safety and Health Act (OSH Act) of 1970. This law created the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH). Additional United States occupational health regulations are specified by other federal laws, including the Federal Coal Mine Health and Safety Act (1969), the Black Lung Benefits Act (1969), and the Toxic Substances Control Act (TSCA, 1976). Additional OSH research and regulatory work is carried out by the Nuclear Regulatory Commission (NRC) and the Environmental Protection Agency (EPA).

Training and education in OEM

Medical education

There are more than 120 medical schools in the United States. Most of them include OEM in didactic teaching, usually as part of the epidemiology and public health curriculum. Unfortunately, the exposure usually consists of no more than 4–6 h in the 2nd or 4th (and final) year of the medical school curriculum. Clinical and research rotations in OEM are uncommon and are generally offered as electives, if at all. Current efforts to increase exposure to OEM are under way, including several special programs funded by the National Institute of Environmental Health Sciences (NIEHS, Program of Academic Awards in OEM) and the NIOSH.

Graduate medical education

Graduate training in OEM follows guidelines established at the national level by the Accreditation Council on Graduate Medical Education (ACGME) [1]. ACGME is an independent (nongovernmental) professional organization consisting of representatives from the American Board of Medical Specialties, the American Hospital Association, the American Medical Association, and the Council of Medical Specialty Societies. Participation of individual programs in the ACGME accreditation program is voluntary but practically indispensable. ACGME has established requirements for accreditation of preventive medicine graduate training (residency) programs, which offer three areas of specialization: general preventive medicine, OEM, and aerospace medicine. These programs consist of formal course work; clinical training, including work-site practicum rotations; and, in some programs, research training and experience. Course work usually leads to a Master of Public Health (MPH) or equivalent degree. Clinical experience is provided through a combination of rotations through hospital-based OEM clinics and on-site industrial health facilities. Physicians are usually accepted into the programs after at least 1 year of postgraduate clinical training (internship) in a primary-care specialty (usually internal medicine or family practice). Training in OEM typically takes 3 years in total, including the internship year. There are only about 20 OEM training programs in the United States, and there is a well-documented shortage of OEM practitioners [4].

Allied health professions

Approximately 40 educational institutions provide formal training in industrial hygiene, the science of the anticipation, recognition, evaluation, and control of occupational health hazards. Many of these programs receive direct support from NIOSH. Between 1971 and 1992, NIOSH-sponsored programs awarded 2,406 master's degrees and 192 doctoral degrees in industrial hygiene. Program curricula typically include training in toxicology, ventilation, epidemiology, statistics, management, and regulation as well as fundamentals in hazard assessment and control techniques.

Approximately 215 educational institutions offer formal training at the baccalaureate level in occupational health nursing to provide recipients with skills in direct care, counseling, and medical management services to workers [13]. Between 1973 and 1992, NIOSH-sponsored programs awarded 512 master's degrees and 18 doctoral degrees in occupational health nursing. The nursing curriculum includes occupational health nursing theory, community health nursing, health program planning and development, biostatistics, epidemiology, toxicology, and basic training in industrial hygiene principles [12].

Educational resource centers

In 1977, in response to the OSH Act of 1970, NIOSH sponsored the establishment of educational resource centers (ERCs), which are currently based at 14 academic institutions (or consortia of institutions) throughout the United States. The ERCs provide undergraduate, graduate, and continuing education and outreach for occupational safety and health professionals (industrial hygienists, physicians, nurses, and safety engineers, among others). They also offer occupational and environmental health education to professionals, workers, and community members in general.

Other OEM educational resources

OSHA supports labor occupational health programs, which are mainly directed toward workers. A number of voluntary and union-based organizations are also heavily involved in providing occupational health information to workers in their communities as well as in advocacy for improvements in workplace safety. Committees for Occupational Safety and Health (COSH) have been established in many states. These consist of associations of occupational safety and health profes-

sionals and other interested individuals. Their range of activities includes safety and health training and continuing education, advocacy, investigation of specific hazards, and industrial hygiene consulting services. There may be more than one COSH in some states (e.g., there are seven in New York State). Large unions often have their own occupational health and safety departments and/or professionals that actively participate in OEM training and related activities.

Professional associations and societies

Several professional associations group OEM professionals, strive to maintain a high standard of practice, advocate occupational and environmental issues, promote exchange of ideas and information, and sponsor educational programs.

The American Conference of Governmental Industrial Hygienists (ACGIH) is a professional association that began as a conference held by industrial hygienists employed at different levels of the government. However, ACGIH is a nongovernmental organization. It was established in 1938, and 3 years later it formed a committee dedicated to the investigation and recommendation of safe occupational exposure limits. ACGIH threshold limit values (TLVs), or exposure limits, for chemical substances and physical agents are regularly revised, as are other biological exposure indices. Revisions follow an established procedure, with changes being implemented over a period of years following a published ''notice of intended changes.'' Industrial hygiene professionals, both in the United States and internationally, recognize the ACGIH TLVs as useful guidelines for assessment of occupational exposure.

The American College of Occupational and Environmental Medicine (ACOEM), founded in 1916, is a North American medical society devoted to promoting the optimal health and safety of workers, workplaces, and environments. The ACOEM has 31 component societies in the United States, Canada, and Mexico, with over 7,000 physician members specializing in occupational and environmental medicine. The ACOEM views their mission as providing leadership to advance the field of occupational and environmental medicine, stimulate research, educate health professionals and the public, guide public policy, and enhance the quality of occupational and environmental medicine practice.

The American Industrial Hygiene Association (AIHA) is the other major organisation of industrial hygienists in this country. It was established in 1939 and promotes the exchange of information and ideas among OEM professionals.

The Association of Occupational and Environmental Clinics (AOEC) consists of a network of clinical facilities (currently 53), most of which are based at or affiliated with academic medical centers. These facilities provide clinical services and are frequently involved in research and education in the prevention and treatment of occupational and environmental diseases. Individual OEM professionals can also become members of the AOEC. The goal of the AOEC is to promote a high standard of care in OEM. It also sponsors educational programs related to OEM.

Regulations and authorities for OEM practice

The regulatory framework for occupational medical practice is mainly provided by agencies in charge of establishing and enforcing exposure limits and by the Workers' Compensation Board system, which establishes guidelines for medical evaluation and treatment, including compensation for work-related injuries and illnesses. This is discussed below at the governmental level (federal and state) at which the regulations are administered.

Federal level

The OSH Act of 1970 established a ''general duty clause'' that specifically required employers to provide a safe workplace for all employees. It also created OSHA and NIOSH. These two institutions were placed under the Department of Labor (DOL) and that of Health and Human Services (DHHS), respectively. NIOSH is largely charged with research, training, and education tasks, whereas OSHA is a regulatory and enforcement agency. The OSH Act permitted OSHA to adopt any prevailing federal or national consensus standards for the first 2 years following its enactment in 1970. Consequently, with regard to regulatory control of workplace exposures, current permissible exposure limits (PELs) follow the TLVs recommended by the nongovernmental ACGIH that were adopted in 1968. NIOSH also tests and certifies protective equipment such as respirators.

OSHA does not regulate all workplaces in the United States. The Department of Transportation (DOT) is responsible for some occupational regulations, along with the Federal Aviation Administration (FAA), the Federal Highway Administration (FHWA), the Research and Special Programs Administration (RSPA), the United States Coast Guard (USCG), and the Federal Railroad Administration (FRA).

Workers' Compensation programs are administered by individual states (see below). The federal government is directly responsible for a limited number of Workers' Compensation programs, including that for all federal employees.

State level

Federal OSHA delegates primary inspection and enforcement functions to some state OSH agencies, provided that they adopt and enforce standards considered

as effective as those of federal OSHA. Although available for consultations to employers and for response to individual workers' concerns or complaints, the representatives of state OSH agencies are mostly dedicated to meeting compliance-oriented requirements. In many states, large budgetary cuts have largely limited the availability of these agencies' inspectors and the efficacy of their work. Compromise solutions are being considered. Some states cover government employees' OSH through separate agencies.

Workers' Compensation boards (WCBs) are individual state organizations. There are differences among state WCBs. Workers' Compensation is a no-fault system that excludes work-related claims from civil tort suits and other legal mechanisms of restitution in exchange for prompt payment of injured workers' claims. Employers, in general, are mandated to carry insurance coverage for compensation of injured workers.

OEM clinical practice

The practice of occupational health physicians in the United States can be described in terms of individual professional accreditation requirements, reimbursement systems, and the patterns of clinical services.

Certification

Specialty certification is conferred by the American Board of Preventive Medicine (ABPM). ABPM is an independent nongovernmental national organization that evaluates the credentials of and certifies physicians in preventive medicine and in one of three areas of specialized expertise: occupational medicine, general preventive medicine, and aerospace medicine. For a physician to be allowed to take its certifying examination (''board eligibility''), the ABPM requires a valid medical diploma, training at an ACGME-accredited graduate program, an MPH degree or equivalent, post-training clinical experience in OEM for at least 1 year, and a valid state medical license. The examination has two components: general preventive medicine and one of the three specialties listed above. Simultaneous successful completion of both components is required for board certification.

ABPM has a separate track for evaluation of physicians who have not been formally trained in OEM but have accumulated, through their work and academic interest, experience that can be comparable with formal residency training. After a detailed evaluation of such an individual's formative process the ABPM determines the eligibility of that physician to take the certifying examination.

Specialty boards are nongovernmental, voluntary entities. Strictly speaking, certification by the ABPM (or any other specialty board) is not required of an individual wishing to practice as an OEM physician in the United States. However, board certification is advantageous for physicians, health-care organizations, and other health-care providers. It is expected that increasing competition will encourage most OEM physicians to seek formal ABPM certification. Furthermore, requirement for ABPM certification is currently consistently observed in the hiring or affiliation practices of private health insurance plans (particularly the prepaid or managed-care models).

The United States does not have a national or federal medical licensing system. Each state has its own professional licensing body. Strict verification of educational and training credentials and enforcement of ethical professional standards are among the main functions of licensing boards. Medical licensure is strictly required for clinical practice, specific requirements vary widely among states, and reciprocity between them is generally very limited.

Health services reimbursements

Health-care coverage in the United States is provided through one of the following: private health insurance (including prepaid and fee-for-service models), Workers' Compensation systems, the Armed Forces (for active military personnel) and Veterans Affairs system (for uniformed service veterans), Medicaid (government plan to cover the poorest stratum of the population), and Medicare (designed for retirees, disabled individuals, and patients with chronic renal failure). Most of these health-coverage programs are mutually exclusive, although at times they may be complementary. However, once a case has been described as being at least probably work-related, responsibility for payment is shifted to the Workers' Compensation insurance carrier. A significant proportion (approximately 14%) of the general population is not covered by any of these programs. That uninsured group includes unemployed as well as employed adults and is sometimes referred to as the medically underinsured.

Whereas Workers' Compensation programs are needed to compensate workers who are injured or become ill as a result of their employment, the appropriate means of dealing with occupational diseases is to prevent them. As the American Public Health Association (APHA) policy statement [2], ''Compensation for and prevention of occupational disease,'' points out, ''A failure to construct a compensation system which significantly contributes to the prevention of disease poses the danger of institutionalizing occupational disease.''

Prevention of work-related disease and injury

The ultimate prevention of work-related disease and injury occurs in a milieu that includes social, political, economic, and legal influences (Fig. 1). Consequently, the prevention of occupational disease and injury not

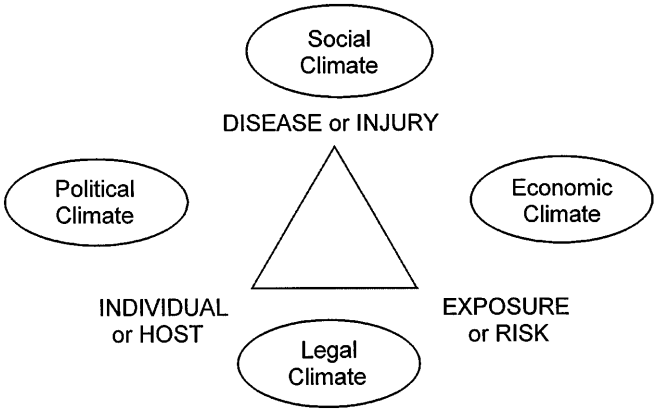

Fig. 1 OEM: The setting for prevention

only requires careful attention to the host or individual, as well as to the risk or agent and disease interaction, but also requires the implementation of strategies that reflect these nonmedical influences.

A model of prevention used in the United States (Fig. 2) shows the important interactions between workers and employers, regulatory agencies such as OSHA and MSHA, and research organizations such as academic institutions or NIOSH. Each of these groups is an important player in driving the prevention of occupational injury and illness, and each of these groups must strive to reduce primary hazardous exposures to avoid the aforementioned "danger of institutionalizing occupational disease and injury."

Types of practice

Traditionally, a large part of OEM practice has occurred in large corporations and industrial facilities. The latter usually employed very large work forces and had their own on-site, fully staffed industrial health facility. These programs generated a significant amount of information about workers' health in specific occupational settings. Although many of these programs remain in place, a major trend has been observed in recent years toward contracting of occupational medical services to independent private organizations.

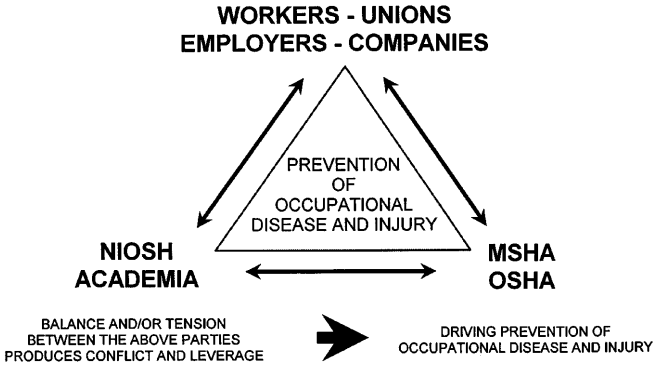

Fig. 2 United States model: triangle of prevention of occupational disease and injury

Private OEM practice provides an increasing proportion of occupational medicine services and includes several practice types: mobile health centers, "free-standing" multispecialty clinics, sole-provider practices, and independent occupational health consultants. Reimbursement is usually done on a fee-for-service basis and, increasingly, by prepaid contract. In most instances, the payer is the employer.

Academic OEM clinics are frequently based at or closely associated with university (tertiary level care) hospitals. This close association tends to limit the level of primary-care activities of these clinics. A trend has been observed toward the "decentralization" of academic OEM clinics along with the establishment of satellite centers that are more accessible to the community and local industries. The latter are usually small- to medium-sized facilities, which are more likely to seek outside occupational health services than to establish on-site clinics.

Several ongoing problems have contributed to the view of OEM as a relatively unattractive specialty. One problem is that Workers' Compensation reimbursement for services provided is either low in comparison with customary fees or very slow. The present health-service provision trends are forcing physicians to be proficient in primary-care medicine. OEM trainees are required to have only 1 year in a primary-care field before they start specialty training. This places them at a disadvantage in view of the present trends in the profession, which is placing strong pressure on all physicians to be proficient in primary-care and general medicine. Finally, the inadequate exposure to the specialty of occupational and environmental medicine during medical education contributes to the discomfort most physicians experience with the intertwined legal and clinical practice environment.

Research in OEM

The major sources of funding for OEM research are the National Institutes of Health, through its Environmental Health Sciences branch (NIEHS), and the Centers for Disease Control and Prevention (CDC), through NIOSH. In addition, important OEM research activities are carried out by several academic medical centers, by corporate and industrial health programs, and by some state agencies.

The NIEHS funds several large centers for research in environmental health sciences. Each of these centers is intended to bring together the expertise of multidisciplinary groups of investigators, with attention being focused on pathogenic mechanisms. Additionally they support doctoral and postdoctoral training programs in disciplines related to OEM.

NIOSH funds a large number of specific, frequently collaborative, extramural research projects as well as

model occupational clinics. Intramural OSH research and surveillance is performed at NIOSH field stations in several geographic locations.

Future prospects in occupational and environmental medicine

Sweeping changes are currently taking place in health-care finance, Workers' Compensation statutes, occupational health and safety regulations (and their enforcement), undergraduate and graduate medical education, and availability of research funds. In the midst of all these changes, it is difficult to anticipate how the field of OEM will be shaped by them.

Training and education

Graduate medical education (GME) is being particularly affected by changes in health-care finance, which in the interest of budgetary readjustments is limiting the traditional funding role of large government programs such as Medicare and the Veterans Administration [6]. The capacity of the specialty training programs exceeds by more than 30% the needs of the classes graduating from American medical schools. Elimination and consolidation of many programs are expected to occur in the next several years.

OEM training does not usually depend on these funding sources. Despite its independence of government financing, no expansion is anticipated in the capacity to train OEM specialists. The impact of NIEHS-funded programs to increase OEM education in medical school curricula remains to be assessed. Making OEM an additional competence or training requirement for primary-care specialists (particularly in internal medicine and family medicine) has been suggested as an alternative method of increasing expertise in the field. Additional efforts may include expansion of continuing medical education and outreach to established primary-care practitioners and increased access to OEM consulting services.

Managed-care organizations are becoming the providers of health-care services to an increasing proportion of the population in the United States. In the interest of cutting costs they have been considerably less interested in GME than have traditional academic medical centers. Although it is yet too early to assess the effects of this relative lack of interest, major changes in GME and medical education in general are expected [3] that are likely to affect OEM education.

Clinical practice

Mounting pressure to decrease overall production costs (including those related to occupational health and safety) is placing increased emphasis on privatization of occupational health services. Large prepaid managed-care health organizations have recently begun to compete for the provision of a limited range of clinical occupational health services, although traditional fee-for-service health organizations are also expected to thrive at the expense of the observed decrease in corporate on-site industrial health services. These practice modalities are largely sponsored by employers and, in general, follow the current trends away from government (federal, state, or local) participation in health-care service provision.

Increasing job instability, competition, and levels of competence and skills required for jobs, combined with decreased expenditures in social benefit programs, are presently exerting additional pressure for the development of effective programs for retraining and vocational rehabilitation of disabled workers. Nevertheless, resources remain very scarce in this area and the response to increased demand will be insufficient

Research

The United States workplace is rapidly changing. Employment patterns continue to shift from the manufacturing sector to the service sector. Longer work hours, often associated with compressed work weeks; shift work; reduced job security; and part-time and temporary work are realities of the modern workplace. New chemicals, materials, processes, and equipment are being developed and marketed at an ever-accelerating pace. The work force itself is changing and is anticipated to reach 150 million individuals by the year 2005. The work force is also aging and becoming more racially diverse. Also, by 2005, minorities will represent 28% of the work force and women will constitute approximately 48%. These demographic changes alone will present new challenges for the protection of workers' safety and health.

Each day an average of 137 individuals die of work-related diseases and an additional 16 die of injuries sustained on the job in the United States. Every 5 s a worker is injured, and every 10 s a worker is temporarily or permanently disabled. Work-related disease and injury is estimated to cost $171 billion annually, rivaling the economic toll of both cancer and heart disease [10].

In recognition of the above-mentioned influences, NIOSH, along with partners in the public and private sectors, has developed the National Occupational Research Agenda (NORA) [5]. This agenda identifies 21 research priorities in 3 major categories: (1) disease and injury, (2) work environment and work force, and (3) research tools and approaches (Table 1). This agenda is truly national in scope. The development and implementation of this agenda has required and will necessitate the active participation of the occupational safety and health community and its broad base of employers, employees, safety and health professionals, public agencies, and industry and labor organizations.

Table 1 NORA priority research areas

Category	Priority research areas
Disease and injury	Allergic and irritant dermatitis
	Asthma and chronic obstructive pulmonary disease
	Fertility and pregnancy abnormalities
	Hearing loss
	Infectious diseases
	Lower back disorders
	Musculoskeletal disorders of the upper extremities
	Traumatic injuries
Work environment and work force	Emerging technologies
	Indoor environment
	Mixed exposures
	Organization of work
	Special populations at risk
Research tools and approaches	Cancer research methods
	Control technology and personal protective equipment
	Exposure assessment methods
	Health services research
	Intervention effectiveness research
	Risk assessment methods
	Social and economic consequences of workplace illness and injury
	Surveillance research methods

In summary, in the 27 years since the passage of the OSH Act, substantial progress has been made in improving workers' protection. Much of this progress has been based on actions guided by OSH research. Fatal work injuries and the rate of disabling injuries have declined substantially. Specific health hazards have been controlled, and some occupational diseases such as byssinosis from cotton-dust exposure and angiosarcoma from vinyl chloride exposure have been nearly eliminated.

Despite the continuing need for OSH research, both public and private sector efforts are facing increasing financial constraints. Budgetary cuts and trends toward deregulation in OSH have the potential to motivate the development of consensus-based mechanisms of collaboration between OSH professionals, employers, OSHA, unions, and employees such that effective surveillance programs can be established and the goal of safer workplaces can be promoted [9].

References

1. American Medical Association Accreditation Council on Graduate Medical Education (1996) Directory of graduate medical education programs. American Medical Association, Chicago
2. American Public Health Association (APHA) (1984) Policy statement. Compensation for and prevention of occupational disease. Am J Public Health 74: 292–295
3. Blumenthal D, Thier SO (1996) Managed care and medical education – the new fundamentals (editorial). JAMA 276: 725–727
4. Castorina JS, Rosenstock L (1990) Physician shortage in occupational and environmental medicine. Ann Intern Med 113: 983–986
5. CDC/NIOSH (1996) National occupational research agenda. CDC Publication 96–115 United States Government Printing Office, Washington, D.C.
6. Dunn MR, Miller RS (1996) The shifting sands of graduate medical education. JAMA 276: 710–713
7. Felton JS (1990) Historical development of occupational medicine in the United States. In: Occupational medical management – a guide to the organization and operation of in-plant occupational health services. Little, Brown and Co., Boston, pp 7–18
8. Hamilton A (1985) Forty years in the poisonous trades. Am J Ind Med 7: 3–18
9. Kono K (1996) OMB A-119 becomes law. ASTM Standardization News 24: 40–42
10. Leigh JP, Markowitz SB, Fahs M, Shin C, Landrigan PJ (1997) Occupational injury and illness in the United States – estimates of costs, morbidity, and mortality. Arch Intern Med 157: 1557–1568
11. Luxon SG (1984) A history of industrial hygiene. Am Ind Hyg Assoc J 45: 731–739
12. Morris SL (1994) Academic occupational safety and health training programs. In: Colligan MJ (ed) Occupational medicine: state of the art reviews, vol 9. Hanley & Belfus, Philadelphia, pp 189–200
13. Rogers B (1991) Occupational health nursing education. Am Assoc Occup Health Nurs J 39: 101–108.