





# OCCUPATIONAL *and* ENVIRONMENTAL RESPIRATORY DISEASE

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*This book is dedicated to three generations of women in my family: Jennifer, Jean, and Dora. Their support, insight, and tolerance have contributed immeasurably.*

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Marc B. Schenker

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John R. Balmes



# FOREWORD

There are many reasons for considering occupational and environmental respiratory diseases separately. Each exposure is the responsibility of a different agency; there are major legal and jurisdictional differences; exposures often involve consideration of different substances. Whereas environmental questions usually involve the general population, occupational risks are primarily contained within specific and well-defined populations. Nevertheless it is instructive to consider the evolution of occupational and environmental respiratory diseases together and to note specific instances in which advance understanding in one area has led to changes in the other.

## OCCUPATIONAL HEALTH

The genesis of occupational medicine can be precisely dated to Ramazzini's book *De Morbis Artificum* in 1713. Dr. Samuel Johnson, the great English lexicographer, was 4 years old at the time; many years later Johnson was to propound the first statement of moral responsibility for diseases contracted by workers on behalf of others. In the nineteenth century the torch of social reform was carried by Charles Dickens, and scrotal cancer in chimney sweepers in London was described by Percival Pott. Scientific and systematic study of an occupational hazard may be dated to 1895 when Haldane published the results of his experiments on himself involving the controlled breathing of carbon monoxide. Early in the twentieth century the public was scandalized by phosphorus poisoning in factory workers, and legislative action was taken to prevent the disease. By the 1930s, both silicosis and coal worker's pneumoconiosis were recognized to be significant problems, and by this date worker's compensation legislation was in place in most jurisdictions. Although the potential hazard of asbestos was beginning to be recognized at the time of the outbreak of World War II in 1939, there was no incentive to pay attention to it—if one was in danger of being torpedoed, the long-term risk of disease caused by asbestos insulation below decks would have seemed laughably remote.

From 1950 onward the study of occupational disease, and in particular occupational respiratory disease, accelerated rapidly. By 1972 the risk of asbestos was becoming generally recognized; the consequences of radon exposure in uranium miners were becoming apparent; new substances such as vinyl chloride were found to be hazardous; and, ten years later, the widely dispersed but common problems of occupationally-induced asthma were being generally recognized. Although the field is still plagued by problems of inadequate funding for training and, in some jurisdictions, dif-

ficulty of access, by 1990 the field of occupational medicine had become well established, with a major component being occupational lung disease

## ENVIRONMENTAL HEALTH

Concern about air pollution stretches back several hundred years in coal-burning countries. Effective action can be dated to the 1946 city ordinance in Pittsburgh and the public concern surrounding the Donora and Meuse Valley episodes. The major London fog in December of 1952, which caused in excess of 4000 deaths, accelerated inquiry and legislation in Britain, and the Industrial West initiated effective controls over the subsequent 20 years. By 1960 the formidable problem of cigarette smoking-induced disease was beginning to be realized, although some years would pass before the magnitude of the adverse health effects attributed to smoking would be recognized. These two environmental exposures and their major effects on respiratory disease have caused environmental lung diseases to be continuing major concern in the general area of environmental health.

By 1980 new environmental problems had been identified. So much lead was being used in gasoline that public exposure had become a justifiable concern. The use of asbestos in public buildings 20 years previous had led to public environmental exposure in schools and libraries; radon had been identified as a problem in some houses in some geologic regions wherein the public could be exposed to levels comparable with those encountered by uranium miners. The careless disposal of chemical wastes from public exposure through a contaminated water supply to a wide spectrum of substances with adverse effects on animals was tested. In addition, new data indicated that new forms of air pollution, leading to the formation of ozone and acid aerosols, were probably affecting the population. Since 1980 the remarkable occurrence of "sick building syndrome" and the phenomenon of acquired general chemical sensitivity (not yet understood) have attracted general attention.

Many environmental problems are characterized by exposure of large populations, by difficulty in characterizing the adverse health outcome (which may affect the reproductive or immunologic system), and by the contentious question of deducing low-level risks from earlier higher-level exposures. Whereas in the 1950s pollution was thought to be a problem for an individual city, by the 1970s it was realized that long-range transmission of pollutants was occurring. By the 1980s the implications of emissions

on earth in regard to stratospheric chemistry and global earth warming were beginning to be understood. As with occupational medicine, respiratory disease from environmental exposures have remained a major area of research and public concern.

### CONVERGENCE OF OCCUPATIONAL AND ENVIRONMENTAL CONCERNS

There has been a remarkable convergence of occupational and environmental concerns in recent years. The case of asbestos is an obvious example. Radon is another. "Sick building syndrome," which may be attributable to exposure to mixtures of volatile organic compound, commonly occurs in offices and, consequently, becomes a disease of occupational origin. Exposure to lead was formerly confined to industrial operatives, but the general uses of lead in gasoline (accompanied by a fivefold increase in the lead content of snow cores in Greenland) has now made it an environmental issue. Fine particulate air pollution has been found to have measurable effects on the general population, which raises interesting issues in relation to occupational dust exposure.

### COMMON LESSONS

Although most of the contemporary concern (and almost all of the news coverage) about health care relates to economic issues, a longer perspective suggests that advances in the understanding of occupational and environmental disease, and particularly respiratory diseases, has come to be seen as highly significant compared with the thinking in 1965. In this progress, several important trends are discernible; these are likely to dominate advances for the next few years.

First, it has been learned that careful characterization of individual exposure (by whatever means possible) greatly strengthens epidemiologic studies. Whereas when the agent is powerful (as in the case of cigarette smoke), linear relationships to risk can be obtained by approximate estimates of lifetime smoking habits. In more common circumstances, to demonstrate the increased risk at all, it may be necessary to refine the exposure data. As with all pendulums, this one can swing too far—there is still a great deal of information to be gained in the absence of precise exposure data.

Second, the use of computers has greatly expanded the potential for epidemiologic studies on large populations. This applies not only to industrially exposed cohorts (such as asbestos-exposed insulators or diesel locomotive drivers)

but also to the exposed general population (such as the exposure to air pollution of modern urban residents). It is possible to use time-series analyses on populations of several millions of people to relate health outcomes such as hospital admissions to environmental parameters.

Third, there have been major advances in statistical methodology, not only in the use of multiple logistic regression techniques and modelling but also in the automated reading of questionnaires and in the methods of time-series analysis. One report suggests that in the case of panel studies of asthmatics, the use of "neural network analysis" may refine conventional methodology.

These advances have not been paralleled by significant progress in the intractable social problems of worker's compensation, in which diseases such as occupational asthma do not fit into legislation that dealt with silicosis written 60 years previously. Some advances have occurred in the process of setting standards, but enforcement in the individual workplace has remained a Cinderella in most places. That some progress has been achieved in the Industrial West became apparent when the appalling environmental degradation in Eastern Europe was revealed with the collapse of Communist regimes. Working conditions and the common environment in those countries, and in much of the third world, resemble those of Britain in the early days of the industrial revolution.

The most recent economic recession in the West was a powerful threat to further advances in the control and prevention of occupational and environmental respiratory disease. It will be the important responsibility of those who understand what has been achieved in these disciplines since the end of World War II to ensure that such gains are not lost in the future.

This new text embodies advances and typifies the common overlaps between occupational and environmental respiratory diseases. Detailed attention is given to problems that are critical to both areas, such as exposure assessment and the use of common tools of the investigative method. It is hoped that the new knowledge that this text encompasses will act as a foundation for long overdue social and political initiatives to mitigate the existence of a major burden of preventable lung disease.

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# PREFACE

Occupational and environmental exposures play major roles in causing many forms of respiratory disease. All humans are exposed to potential occupational or environmental toxins such as indoor or ambient air pollutants or unique respiratory toxins occurring in the workplace. No longer are occupational toxin exposures limited to blue-collar jobs in heavy industries such as mining and manufacturing; significant hazards exist in modern industries and office environments. The disorders resulting from these exposures are diverse in nature, ranging from acute lung injury from toxic gas inhalation to subtle effects of environmental pollutants upon persons with asthma. All aspects of the respiratory system, from the nose to the alveoli, can be affected by inhaled environmental agents; therefore this book seeks to address the full range of respiratory effects of environmental exposures. The respiratory system does not distinguish whether an inhaled agent came from a workplace or a community (nonoccupational) source. For this reason, a unitary approach, jointly considering occupational and environmental respiratory disease, is employed in this book. However, exposure assessment methods and control strategies often differ between workplace and community environments; these differences are discussed.

There are many perspectives and approaches to understanding occupational and environmental respiratory diseases. These include clinical approaches, focused upon the diagnosis and treatment of disease in an individual patient; environmental monitoring perspectives, emphasizing evaluation of the potential exposures; epidemiologic assessment, evaluating patterns of health and disease in *groups* of persons; biologic considerations of the mechanisms by which environmental agents produce disease; and public policy aspects, emphasizing control by regulation and law.

This book is predicated on the belief that approaches to understanding respiratory disease are intertwined, and all must be integrated to prevent and manage such disorders. There is also a strong emphasis on the relationship between disease and exposure, recognizing that disease prevention is directly related to controlling exposure. However, discussion of fundamental biologically oriented research, without direct clinical or public health implications, has been deemphasized. These topics are covered in more detail in other texts.

Figure 1 suggests a “*user’s guide*” for this book. It reflects the organization of the major sections. Section I presents a historical overview of the field. Section II

discusses the major approaches employed in the field, presenting the “tools” (e.g., radiology, epidemiology) from a methodologic standpoint. Section III presents methods employed for assessing exposures. Section IV provides an overview of the major disease categories, emphasizing aspects that are common to the disease group regardless of the etiology. For example, the symptoms and treatment of lung cancer are generally similar regardless of the underlying etiology. A clinician faced with an individual patient with a respiratory disease may move from this section of the book to sections dealing with specific exposures causing a disease or group of diseases.

Sections V and VI discuss disorders resulting from exposure to known agents; specifically, Section V includes the interstitial lung diseases, and Section VI covers disorders that primarily affect the airways. In instances where an agent can produce diseases in either category, the agent is discussed in the section appropriate to the major associated disease and is cross-referenced in the other section.

Section VII includes agents that cause upper airway disorders, cancers, and acute toxic effects. This section also discusses classes of agents such as metals, which may lead to diverse categories of disease. Section VIII discusses industries that are associated with the development of occupational and environmental respiratory disease. In some industries the agent is well identified, whereas in others a complex mixture of etiologic agents exists. Diagnosis and control may be based on general characteristics of the industry rather than on controlling a specific agent. Section IX emphasizes respiratory disorders caused by nonoccupational pollutants in both indoor and outdoor environments.

The next several sections discuss systematic approaches to occupational and environmental respiratory diseases. Section X focuses upon person-oriented approaches, and it includes discussions of disability assessment, accommodation, and rehabilitation of individuals with occupational and environmental respiratory diseases and includes organized surveillance methods for the detection and prevention of disease in *groups*. Section XI addresses occupational and environmental respiratory disease from a policy perspective. The legal and regulatory framework in the United States is discussed. Special considerations are presented for the recognition and control of occupational and environmental respiratory disease in developing nations where resources and approaches to the diagnosis and control of disease may be different. The final section deals with control technologies.

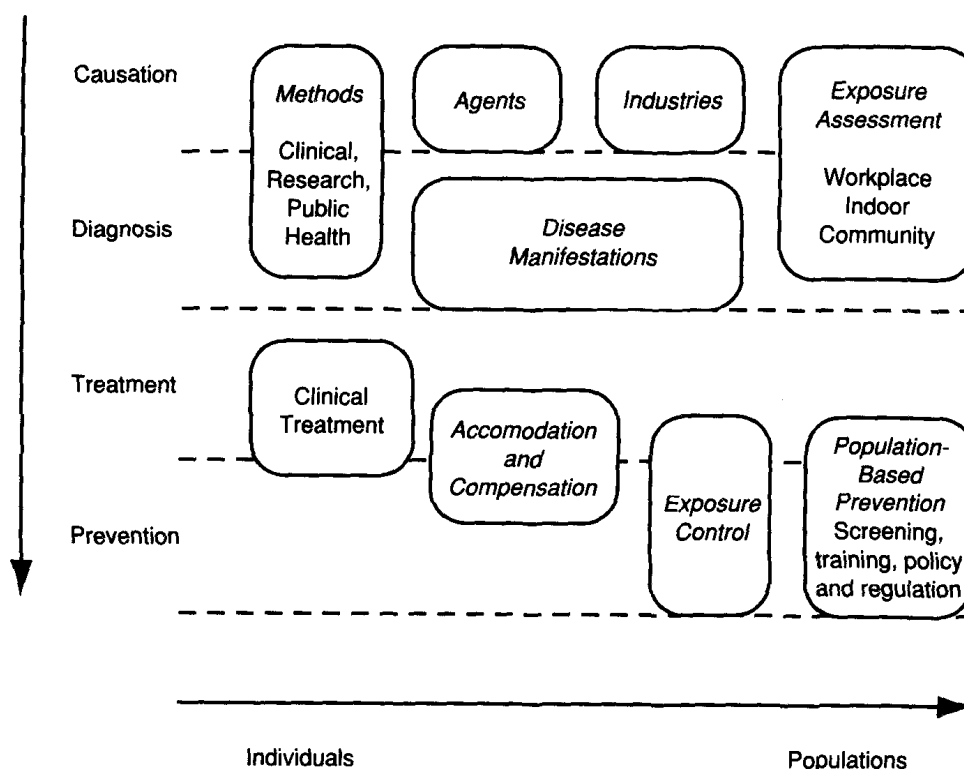


Fig. 1. Occupational and environmental respiratory disease.

Occupational and environmental respiratory disease can be avoided by primary prevention methods that control adverse exogenous exposures. Therefore, assessment of an individual patient should always be accompanied by the questions, "Why did he/she develop this illness?" "Is there an intervention to prevent disease progression?" and "What should be done to prevent this in others?"

As shown in Fig. 1, the book is organized to be used in several ways. For example, the exposure may be known, and the associated diseases requiring control measures may be of interest. Conversely, a clinician with a sick patient in the office may use the general disease category unit as the point of entry. An occupational physician treating a patient with known occupational disease caused by a specific agent may desire more information about methods of confirming the diagnosis, evaluating disease progression, pharmacologic treatment of the disease, or dealing with accommodation and compensation of the injured worker.

Occupational and environmental respiratory disease is a worldwide problem. There are large numbers of cases of disease that still occur, even though these diseases have been known to be preventable for many years. Other diseases are caused by modern industries, and new pollutants and may be particularly common in developed countries at present.

Tobacco use is a major contributor to respiratory disease. In view of the multifactorial etiology of respiratory disease and the interaction of smoking with other exposures, the

presence of one factor (smoking) does not preclude the presence of a significant impact of another occupational or environmental exposure or even a synergistic interaction of both factors.

We hope this book will fill the important need for a comprehensive volume providing integrative approaches to the treatment, prevention, and control of occupational and environmental respiratory disease. The scope is wider than that found in existing textbooks of occupational lung disease. New information about the potentially adverse effects of environmental exposures is included. The often-overlooked upper airway is treated in depth. In addition to the mining and manufacturing industries, which have traditionally received most attention as causes of occupational lung disease, this book includes information about other work settings in which occupational and environmental respiratory disease occurs, such as the health care industry, petroleum industry, office settings, agriculture, semiconductor industries, and others. Indoor air pollution—its health effects, policy implications, and control measures—is covered in detail. Exposure assessment, risk evaluation, hazard communication, and protective measures are also discussed.

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**OCCUPATIONAL**  
*and*  
**ENVIRONMENTAL**  
**RESPIRATORY DISEASE**

# History of Occupational and Environmental Respiratory Disease

JOHN R. BALMES

Occupational and environmental diseases have been of concern to physicians since at least the time of the ancient Greeks. Chapter 1 places modern regulatory efforts in appropriate historical context using efforts to control silicosis as an example.

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## 1 Historical Perspective