Applied Epidemiology

THEORY TO PRACTICE

EDITED BY
Ross C. Brownson
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To Carol and Selene

Foreword

In 1949, the Epidemiology Section of the American Public Health Association celebrated its twentieth anniversary in a session on "The History of American Epidemiology." John Gordon, chairman of the Department of Epidemiology at the Harvard University School of Public Health, spoke on "The Future in Epidemiology." He defined the province and promise of epidemiology in succinct and comprehensive terms:

> As the diagnostic discipline of public health, epidemiology should find increasing usefulness in the definition of health problems, in determining principles to guide programs for control, and in evaluation of accomplishment. The promise of a more scientific and a more statesmanlike public health has a close relationship with operational epidemiology.*

More than 30 years later, in an article on "Epidemiology and the Public Health Movement: A Historical Perspective," Abraham and David Lilienfeld noted that:

> During the past two decades, the discipline of epidemiology has become increasingly divorced from those activities in the real world that result in the improvement of public health. Public health administration was at one time intimately associated with epidemiology. . . . Our excursions in the historical development of epidemiology have led us to realize that epidemiology is closely interwoven with the public health movement, and our study of the evolution of the public health movement has indicated that its roots must be firmly implanted in an epidemiologic base. In order to continue with the past successes of both movements, they must be constantly nourished by each other.†

The great need for a textbook that teaches epidemiology as "the diagnostic discipline of public health," a textbook that is concerned with "usefulness in the definition of health problems, with determining principles to guide programs for control, and with evaluation of accomplishment," becomes abundantly clear when one reviews the content of leading textbooks in the field.

*Winslow, C.-E. A., Smillie, W. G., Doull, J. A., and Gordon, J. E., edited by Top, F. H. *The History of American Epidemiology*. St. Louis: C. V. Mosby, 1952.

†Lilienfeld, A. M., and Lilienfeld, D. E. "Epidemiology and the Public Health Movement: A Historical Perspective," *J. Public Health Policy* 3 (1982): 140–49.

For example, the third (1994) edition of *Foundations of Epidemiology*, revised by David Lilienfeld and Paul Stolley, resembles its previous editions in that it provides practically no discussion of the use of epidemiology in public health practice. On the other hand, as the authors state, "a new chapter on the use of epidemiologic information in clinical settings has been added to this edition." The new chapter has two sections: (1) Clinical Decision Making and (2) Reading and Interpreting Scientific Literature.

In sharp contrast, *Applied Epidemiology: Theory to Practice* considers epidemiology to be, as John Gordon said, "the diagnostic discipline of public health." Its 12 chapters provide a thorough and comprehensive analysis of problems, issues, and methods, and describes the advantages and disadvantages of various alternative approaches. In addition, the case studies of actual programs which conclude each chapter emphasize the authors' orientation to the real world of public health practice.

Applied Epidemiology: Theory to Practice is the book that the public health movement has been waiting for. It will be treasured by every public health worker who needs state-of-the-art information and guidance in defining health problems and attempting to solve them. It needs to be studied by policy-makers in all levels of government, in the schools of public health, and in the state and national public health associations. There has been no recognition of the crucial need for a large-scale program of federal aid to remedy the severe shortage of trained epidemiologists in state and local health departments, and to finance the development of a truly adequate information system that will provide health departments with the data required for effective planning and monitoring of programs and services. Commitment and leadership by the public health movement are essential to convince federal administrators and the Congress of the rich promise of epidemiology so clearly demonstrated by this landmark volume.

Milton Terris, MD, MPH

Preface

These are exciting times for epidemiology. Because of the increasingly large demand for epidemiologic expertise and the many advances in epidemiologic methods, both the opportunities and challenges in this field have never been greater. The advances in epidemiologic methods afford more sophisticated ways to evaluate the health risks associated with many exposures and with environmental contaminants in modern society. New information technologies, including powerful microcomputers, software, and the Internet, offer exciting opportunities for the conduct of a broader array of studies. Changes in how health care is delivered, particularly the growth of organized systems of care, open new chances for epidemiologists to become involved in population-based medicine and the assessment of health care utilization and quality. Despite the vast potential of epidemiology, decisions are frequently made and policy is often formed in the absence of sound epidemiologic data and scientific reasoning.

The need for this book became clear as a result of the authors' day-to-day work in public health and health care, experiences in the classroom, and discussions with colleagues. Individual epidemiologists and several expert advisory bodies have called for stronger links between educational institutions and public health practice: One link may include a curriculum in epidemiology that more closely reflects the day-to-day practice of public health.

In our view, applied epidemiology synthesizes and applies the results of etiologic studies to set priorities for intervention; it evaluates public health interventions and policies; it measures the quality and outcome of medical care; and it effectively communicates epidemiologic findings to health professionals and the public. Within this broad framework, the chapters in this book were chosen to emphasize some of the areas of public health practice in which systematic application of epidemiologic methods can have a large and positive impact. A major goal is to extend the scope of more traditional epidemiology books that tend to focus only on methods for determining disease etiology (e.g., study design, sources of bias, causal reasoning).

Following an introductory chapter, three overview chapters deal with study design and interpretation, methods in outbreak and cluster investiga-

tions, and principles of public health surveillance. The remaining eight chapters cover important contemporary topics that have strong conceptual or methodologic linkages with epidemiology. The chapters are designed to highlight key issues and to provide practical recommendations. Case studies at the end of each chapter illustrate major points and provide a basis for teaching exercises. Each case study follows a standard format (i.e., background, key questions, and implications for practice).

Topics covered in this book underline the multidisciplinary nature of epidemiology. Even within the overall science of epidemiology, there are a number of subdisciplines, such as clinical epidemiology, behavioral epidemiology, occupational epidemiology, chronic disease epidemiology, infectious disease epidemiology, and environmental epidemiology. In this regard, our book is intended to complement other recent Oxford texts in epidemiology and biostatistics.

The target audience for this text includes practicing epidemiologists, students in epidemiology, and practitioners and students in related disciplines that rely heavily on epidemiologic methods and reasoning. We hope the book will be useful in academic institutions, state and local health agencies, federal agencies with significant training missions, and health care organizations. Although the book is intended primarily for a North American audience, examples are drawn from all parts of the world and we believe that much of the information will be applicable in any developed or developing country. If used in course work, the students should already be familiar with the basic concepts in epidemiology.

Epidemiologic reasoning and methods inevitably will move beyond the boundaries of etiologic research and become integral to the practice of public health and the delivery of health care. We believe this book will be a useful resource.

August, 1997

R. C. B.
D. B. P.

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Contents

Applied Epidemiology

1

Epidemiology: The Foundation of Public Health

ROSS C. BROWNSON

Epidemiology has a rich, yet relatively brief history in determining the underlying causes of numerous health conditions and in assessing the effectiveness of preventive strategies and technologies. In part because it is such a new science, epidemiologists have focused much of their attention over the past few decades on the development and refinement of research methods; less emphasis has been placed on how to effectively apply epidemiologic principles to public health and health care.

This chapter briefly reviews some of the historical contributions of epidemiology and some of the most pressing current issues encountered in the application of epidemiologic methods. Many of the topics discussed here are covered in more detail in later chapters.

Scope and Definitions of Epidemiology

Epidemiology is often considered the basic science of public health. This pivotal role was emphasized by the Institute of Medicine in its definition of public health as "organized community efforts aimed at the prevention of disease and promotion of health. It links many disciplines and rests upon the scientific core of epidemiology" (Committee for the Study of the Future of Public Health 1988).

Since the 1920s, several dozen definitions of epidemiology have been advanced (Lilienfeld 1978). A widely accepted version is "the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to control of health problems." (Last 1995). Perhaps the most comprehensive definition, and the one most relevant to public health practice, was crafted by Terris (1992):

Epidemiology is the study of the health of human populations. Its functions are:

1. To discover the agent, host, and environmental factors which affect health, in order to provide the scientific basis for the prevention of disease and injury and the promotion of health.
2. To determine the relative importance of causes of illness, disability, and death, in order to establish priorities for research and action.
3. To identify those sections of the population which have the greatest risk from specific causes of ill health, in order that the indicated action may be directed appropriately.
4. To evaluate the effectiveness of health programs and services in improving the health of the population.

Each of these four functions directly applies to improving the overall health of the population. Recognition of epidemiology's role in improving the overall health of the public was not consistently present in earlier definitions (Lilienfeld 1978).

Many in epidemiology and public health may view the linkage between etiologic research and public health intervention as implicit. However, it has been observed that "the discipline of epidemiology has become increasingly divorced from those activities in the real world that result in the improvement of public health" (Lilienfeld and Lilienfeld 1982). Expressing a similar concern, Pearce (1996) noted that epidemiology "has become a set of generic methods of measuring associations of exposure and disease in individuals, rather than functioning as part of a multidisciplinary approach to understanding the causation of disease in populations." Although epidemiologists need not be health promotion activists, they should work closely with communities, public health agencies, and health care providers to ensure the sound application of epidemiologic research (Wynder 1985).

Historical Aspects

Table 1-1 provides an abbreviated summary of key events in the evolution of epidemiology. The underpinnings of epidemiology and its relationship to health promotion and disease prevention go back as far as ancient Greek civilization. In his work *On Airs, Waters, and Places*, Hippocrates recommended that physicians attend to "the mode in which the inhabitants live and what are their pursuits, whether they are fond of drinking and eating to excess, and given to indolence, or are fond of exercise and labor, and not given to excess in eating and drinking" (Hippocrates 1938). During the next 2,000 years, causes of disease were considered without much emphasis on measuring their impact (Hennekens and Buring 1987). John Graunt's analysis of weekly births and deaths in London is one of the earliest examples of a descriptive epidemiologic study. William Farr was the superintendent

Table 1-1. Selected Milestones in the Historical Development of Epidemiology

Year	*Event*
400 B.C.	Hippocrates suggested that the development of human disease might be related to lifestyle factors and the external environment
1600s	Bacon and others developed principles of inductive logic, forming a philosophical basis for epidemiology
1662	Graunt analyzed births and deaths in London and quantified disease in a population
1747	Lind conducted a study of treatments for scurvy—one of the first experimental trials
1839	Farr set up a system for routine summaries of causes of death
1849–1854	Snow formed and tested a hypothesis on the origins of cholera in London—one of the first studies in analytic epidemiology
1920	Goldberger published a descriptive field study showing the dietary origins of pellagra
1949	The Framingham Heart Study was begun—among the first cohort studies
1950	Doll and Hill, Levin et al., Schreck et al., and Wynder and Graham published the first case-control studies of cigarette smoking and lung cancer
1954	Field trial of the Salk polio vaccine was conducted—the largest formal human experiment
1959	Mantel and Haenszel developed a statistical procedure for stratified analysis of case-control studies
1960	MacMahon published the first epidemiology text with a systematic focus on study design
1964	The US Surgeon General's Advisory Committee on Smoking and Health establish criteria for evaluation of causality
1971–1972	North Karelia Project and Stanford Three Community studies are launched—the first community-based cardiovascular disease prevention programs
1970s	New multivariate statistical methods developed, such as log-linear and logistic analysis
1970s–present	Invention and continuing evolution of microcomputer technologies allowing linkage and analysis of large databases
1990s	Development and application of techniques in molecular biology to large populations

of the Statistical Department of the Registrar General's Office of England and Wales from 1839 to 1879 and is considered the founder of the modern disease surveillance due to his work in collecting and reporting vital statistics (Thacker and Berkelman 1988).

The evolution of modern epidemiology, marked by many of the milestones noted in Table 1-1, has been broadly divided into three stages: sanitary