PRIMER OF EPIDEMIOLOGY

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To Ruth,
Emily,
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PREFACE

It has seemed to me that many health-care professionals do not have an adequate understanding or appreciation of what epidemiology is all about or how it relates to their own work. Furthermore, one frequently finds a failure in communication between the clinician and the epidemiologist despite their common concern over human health and disease. I believe it is fair to say that most students of medicine and other health sciences regard epidemiology as a boring and irrelevant subject which they study only because they are required to. Another common view of epidemiology among health-care professionals is that it is highly esoteric or mathematical and too complex for them to understand.

With those problems in mind I have attempted to write a concise textbook for physicians, medical students, and other health-care professionals that would explain epidemiologic concepts clearly and simply. I have also tried to bridge the gap in communication between the clinician and epidemiologist in a variety of ways, such as providing a number of clinical examples throughout the book,

explaining to the clinician why the epidemiologic emphasis on the study of groups rather than individuals is necessary, and trying to show the relevance of epidemiology to the major concerns of the clinician such as diagnosis and choice of therapy. Also, I have described several interesting epidemiologic studies to illustrate various methods of investigation. Rather than showing just tables of data to illustrate the results of these studies, I have tried to describe them in sufficient detail so the reader will come away with a real feeling for what it is like to carry out an epidemiologic study. I have attempted, also, to provide some much sought-after practical advice on how to conduct a simple epidemiologic or clinical study and on critical reading of the medical literature. Finally, there is some discussion of epidemiology in relation to the study of problems currently of great social and political importance—the changing health care system and environmental hazards.

Some epidemiologists may be disappointed at the lack of discussion of some of the epidemiologic classics such as Snow's studies of cholera or Goldberger's studies of pellagra. Despite the importance and beauty of these studies, I believe that most students are much more interested in examples that relate to current health and social problems.

Few, if any, of the ideas and concepts in this book are original. I am deeply indebted to those who trained me in epidemiology and related subjects and to the many colleagues and friends with whom I have worked over the past decade for all I have learned from them. A number of the examples, references, and other materials that appear here were suggested to me by colleagues, to whom I am most grateful. It would be impossible for me to name all who, in one way or another, helped me to write this book, but I hope they are aware of my appreciation.

I would like to single out for special thanks Dr. Loring G. Dales, Dr. Mark J. Yanover, and my wife, Ruth, who read the entire manuscript carefully during its preparation and made many valuable suggestions. I am grateful to Mrs. Agnes M. Lewis for carefully typing the manuscript and drawing some of the figures, and to Dr. Morris F. Collen for his advice and encouragement.

Gary D. Friedman

Chapter 1

Introduction to Epidemiology

EPIDEMIOLOGY: DEFINITION, PURPOSE, AND RELATION TO PATIENT CARE

Epidemiology is the study of disease occurrence in human populations. The primary units of concern are *groups* of persons, not separate individuals. Thinking in epidemiologic terms often seems foreign to clinicians and other health-care professionals, who are trained to think of the unique problems of each particular patient.

Whether one focuses on individuals or groups should depend upon what one is trying to accomplish. In caring for a sick patient, the need to individualize the diagnosis and treatment for that unique patient is obvious. However, groups of persons must be studied in order to answer certain important questions. These questions often relate to the etiology and prevention of disease and to the allocation of effort and resources in health-care facilities and in communities.

Some examples of questions that require epidemiologic study of human populations are:

When can we expect the next influenza epidemic?
Why are we seeing so much coronary heart disease these days?
How can cancer of the uterine cervix best be prevented?
How often should healthy patients be given medical checkups and what examinations and tests should these checkups include?

Although they also focus on groups, clinical studies of the natural course of disease or the effects of treatments should be distinguished from epidemiologic studies. In general, epidemiologists are more concerned with disease patterns in natural populations such as communities or nations. Clinical studies, on the other hand, are concerned with groups of *patients* seen in a medical facility. However, the methods of investigation are often quite similar, so that training and experience in epidemiology are useful for the clinical investigator.

In addition to being related to clinical research, epidemiology is intimately involved in clinical practice. Clinicians regularly use epidemiologic knowledge in the diagnosis and treatment of disease. Accordingly, after the elements of epidemiology are presented in subsequent chapters, the relationship of epidemiology to clinical research and to medical care will be described.

How Epidemiology Contributes to Understanding Disease Etiology

Each scientific discipline in medicine is uniquely able to answer certain questions. If our goal is to understand how a particular disease occurs, each discipline can attack the problem at its own level and contribute to our understanding.

It is sometimes implied that the purpose of epidemiology is to provide clues to etiology which can later assist the laboratory scientist in arriving at the real answer. This is a distorted view. There are certain questions that can only be answered outside of the laboratory.

A new vaccine may be developed and prepared by biologists

and biochemists, but epidemiologists will have to answer whether the vaccine is successful in preventing disease.

Similarly, laboratory scientists can identify carcinogenic compounds in tobacco smoke and may even be able to produce lung cancer in experimental animals by forcing them to smoke cigarettes. However, the idea that cigarette smoking causes human lung cancer would be unconvincing unless epidemiologists also showed that lung cancer occurred more often in cigarette smokers than in nonsmokers.

Causation of Disease A moment's thought about any disease reveals that more than one factor contributes to its occurrence. For example, tuberculosis is not merely caused by the tubercle bacillus. Not everyone exposed to the tubercle bacillus becomes ill with tuberculosis. Other factors have been identified which clearly contribute to the occurrence of this disease. These factors include poverty, overcrowding, malnutrition, and alcoholism. Amelioration of these other factors can do much to prevent this disease.

Epidemiologists have organized the complex multifactorial process that leads to disease in various ways. One useful way to view the causation of some diseases, particularly certain infectious diseases, is in tripartite terms of the agent, the environment, and the host. For acute rheumatic fever the agent is the beta-hemolytic streptococcus. However, not all persons infected with this organism develop the disease. Thus, considerations of host susceptibility are important. Constitutional factors appear to play a role not only in whether or not the disease develops but also in the localization of cardiac damage. Important environmental factors include social conditions such as poverty and crowding as well as nonhuman aspects of the environment such as season, climate, and altitude.

Another epidemiologic view of disease etiology is as a "web of causation." This concept of disease causation considers all the predisposing factors of any type and their complex relations with each other and with the disease. One current view of the multiple factors leading to myocardial infarction well illustrates a causal web (Fig. 1-1). (Despite the apparent complexity of this diagram, it is undoubtedly an oversimplification and will certainly be modified by further study.) Note that many interrelated factors ultimately lead to

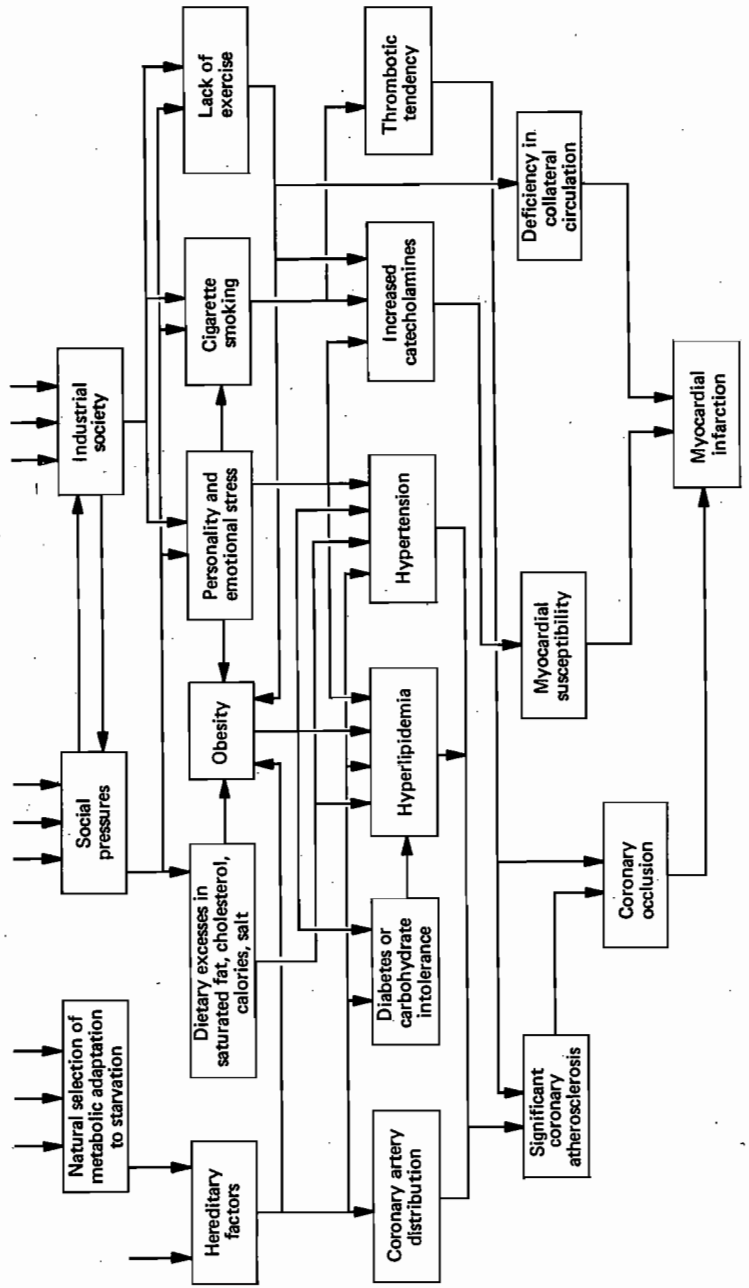

Figure 1-1 The web of causation for myocardial infarction: a current view.

myocardial infarction. Each of these factors mentioned is also influenced by a variety of other factors not shown, leading to as complex a causal web as one chooses to construct. Nevertheless, based on the information presented, it can be seen that a variety of actions could be taken which might reduce the occurrence of myocardial infarction. These actions include dietary modifications, treatment of hypertension, and changing public attitudes toward smoking and exercise.

It is tempting to search for a primary cause, or the most important or most direct of the many causal factors. The benefits of this search are perhaps more philosophical or psychological than practical. In terms of disease prevention it may be most practical to attack a causal web at a spot that seems relatively remote from the disease. To prevent malaria, we do not merely try to destroy the malaria parasite; rather, we drain swamps to control the mosquito population, since this is a practical and effective approach. Similarly, economic development and general improvements in living conditions seem to have done more to reduce mortality from tuberculosis than any chemotherapeutic agent directed specifically at the tubercle bacillus.

Definition and Classification of Diseases

No discussion of disease causation would be complete without some comment about the relatively arbitrary and varying ways in which diseases are defined.

What physicians are faced with are ill persons! However, it has been convenient and valuable to divide the ill persons into categories and give each category a name. We call each category a disease. Ill people do not always fit well into our categories, as any physician will discover if he tries to practice medicine using only the textbooks.

We name diseases to reflect something about our perception or understanding of what the disease entails. Some disease names are merely descriptive of some aspect such as appearance (e.g., erythema multiforme) or subjective sensation (e.g., headache). Some names probe a bit deeper but are still descriptive of pathologic anatomy, often as defined by gross or microscopic appearance (e.g.,

adenocarcinoma of the colon or fracture of the femur). On the other hand, the disease name may focus on some real or supposed causative factor; e.g., pneumococcal pneumonia implies a pulmonary infection by the pneumococcus.

As knowledge about disease causation increases, the disease names are often switched from descriptive terms to terms implying a causal factor. Many ill persons who had been formerly named by a variety of descriptive terms become reclassified under a single causal heading. Similarly, a single descriptive heading may have contained patients with a variety of causally defined diseases. One of the former names for the condition we now call tuberculosis was *phthisis*, meaning "wasting away." Patients in whom wasting dominates the clinical picture constitute only a portion of persons with tuberculosis, and tuberculosis is only one of the causes of wasting.

Causal names for disease are useful in that they immediately imply means for prevention or therapy; in fact, they can drastically change the manner in which a particular health problem is handled. However, causal names can also lead to problems. When the focus on one causal factor such as an infectious agent is reflected in the disease name, we often forget that other factors are operating and tend to regard the infectious or other agent as the only cause.

In summary, disease names are important tools for thought and communication. However they must be viewed in proper perspective. They tend to mask differences among patients, and they have a way of influencing and narrowing our thinking. Disease names may even become "the thing itself," whereas the emphasis should be on the ill person. Furthermore, disease names are transitory. The naming and classifying of ill persons has changed markedly through history and will continue to change.

REFERENCE

MacMahon, B., and T. F. Pugh, *Epidemiology: Principles and Methods.* (Boston: Little, Brown, 1970), Chaps. 1, 2, and 4.

Chapter 2

Basic Measurements in Epidemiology

There is one thing I would be glad to ask you. When a mathematician engaged in investigating physical actions and results has arrived at his conclusions, may they not be expressed in common language as fully, clearly, and definitely as in mathematical formulae? If so, would it not be a great boon to such as I to express them so?

Michael Faraday,
Letter to James Clerk Maxwell

Epidemiology is a quantitative science. Its measured quantities and descriptive terms are used to describe *groups* of persons.

Counts The simplest and most frequently performed quantitative measurement in epidemiology is a count of the number of persons in the group studied who have a particular disease or a particular characteristic. For example, it may be noted that 10 people