STA 2130:Fundamentals of Biostatistics

Lesson 4:Epidemiology

October 7, 2024

Introduction

After studying this lesson and you will be able to:

- Define epidemiology
- Summarize the historical evolution of epidemiology.
- Describe the elements of a case definition and state the effect of changing the value of any of the elements.
- List the key features and uses of descriptive epidemiology
- List the key features and uses of analytic epidemiology.
- ist the three components of the epidemiologic triad
- List and describe primary applications of epidemiology in public health practice
- List and describe the different modes of transmission of communicable disease in a population

part I

Introduction

The word **epidemiology** comes from the Greek words *epi*, meaning "on or upon," *demos*, meaning "people," and *logos*, meaning "the study of."

Many definitions have been proposed, but the definition captures the underlying principles and the public health spirit of epidemiology is:

"**Epidemiology** is the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems."

This definition includes several terms which reflect the important principles of the discipline.

Study: Epidemiology is a scientific discipline, sometimes called "the basic science of public health." It has, at its foundation, sound methods of scientific inquiry.

Distribution: Epidemiology is concerned with the frequency and pattern of health events in a population. Frequency includes not only the number of such events in a population, but also the rate or risk of disease in the population. The rate (number of events divided by size of the population) is critical to epidemiologists because it allows valid comparisons across different populations. Pattern refers to the occurrence of health-related events by time, place, and personal characteristics.

- **Time** characteristics include annual occurrence, seasonal occurrence, and daily or even hourly occurrence during an epidemic.
- Place characteristics include geographic variation, urban-rural differences, and location of worksites or schools.
- Personal characteristics include demographic factors such as age, race, sex, marital status, and socioeconomic status, as well as behaviors and environmental exposures.

This characterization of the distribution of health-related states or events is one broad aspect of epidemiology called **descriptive epidemiology.**

Descriptive epidemiology provides the What, *Who, When,* and *Where* of health-related events.

Determinants: Epidemiology is also used to search for causes and other factors that influence the occurrence of health-related events.

Analytic epidemiology attempts to provide the *Why* and *How* of such events by comparing groups with different rates of disease occurrence and with differences in demographic characteristics, genetic or immunologic make-up, behaviors, environmental exposures, and other so-called potential risk factors.

Under ideal circumstances, epidemiologic findings provide sufficient evidence to direct swift and effective public health control and prevention measures.

Evolution of epidemiology

Although epidemiologic thinking has been traced from Hippocrates (circa 400 B.C.) through Graunt (1662), Farr, Snow (both mid-1800's), and others, the discipline did not blossom until the end of the Second World War. The contributions of some of these early and more recent thinkers are described below.

- Hippocrates (circa 400 B.C.) attempted to explain disease occurrence from a rational instead of a supernatural viewpoint. In his essay entitled "On Airs, Waters, and Places," Hippocrates suggested that environmental and host factors such as behaviors might influence the development of disease.

Evolution ....

- Another early contributor to epidemiology was John Graunt, a London haberdasher who published his landmark analysis of mortality data in 1662.
- He was first to quantify patterns of birth, death, and disease occurrence, noting male-female disparities, high infant mortality, urban rural differences, and seasonal variations.
- No one built upon Graunt's work until the mid-1800's, when William Farr began to systematically collect and analyze Britain's mortality statistics. He is considered the father of modern vital statistics and surveillance, developed many basic practices used today in vital statistics and disease classification. He extended the epidemiologic analysis of morbidity and mortality data, looking at the effects of marital status, occupation, and altitude. He also developed many epidemiologic concepts and techniques still in use today.

- an anesthesiologist named John Snow was conducting a series of investigations in London that later earned him the title “the father of field epidemiology.” Twenty years before the development of the microscope, Snow conducted studies of cholera outbreaks both to discover the cause of disease and to prevent its recurrence. Because his work classically illustrates the sequence from descriptive epidemiology to hypothesis generation to hypothesis testing (analytic epidemiology) to application, we will consider two of his efforts in detail.
- Snow conducted his classic study in 1854 when an epidemic of cholera developed in the Golden Square of London. He began his investigation by determining where in this area persons with cholera lived and worked. He then used this information to map the distribution of cases on what epidemiologists call a **spot map.**

- In the mid- and late-1800's, many others in Europe and the United States began to apply epidemiologic methods to investigate disease occurrence. At that time, most investigators focused on acute infectious diseases.
- In the 1900's, epidemiologists extended their methods to noninfectious diseases. The period since the Second World War has seen an explosion in the development of research methods and the theoretical underpinnings of epidemiology, and in the application of epidemiology to the entire range of health-related outcomes, behaviors, and even knowledge and attitudes.
- The studies by Doll and Hill linking smoking to lung cancer and the study of cardiovascular disease among residents of Framingham, Massachusetts, are two examples of how pioneering researchers have applied epidemiologic methods to chronic disease since World War II. Finally, during the 1960's and early 1970's health workers applied epidemiologic methods to eradicate smallpox worldwide. This was an achievement in applied epidemiology of unprecedented

Uses of epidemiology

Epidemiology and the information generated by epidemiologic methods have many uses. These uses are categorized and described below;

- **Population or community health assessment.**: To set policy and plan programs, public health officials must assess the health of the population or community they serve and must determine whether health services are available, accessible, effective, and efficient. To do this, they must consider many questions:
  - What are the actual and potential health problems in the community?
  - Where are they?
  - Who is at risk?
  - Which problems are declining over time?
  - Which ones are increasing or have the potential to increase?
  - How do these patterns relate to the level and distribution of services available?

- Descriptive and analytic epidemiology provide ways to answer these and other questions. With answers provided through the application of epidemiology, the officials can make informed decisions that will lead to improved health for the population they serve.

- **Individual decisions.** People may not realize that they use epidemiologic information in their daily decisions. When they decide to stop smoking, take the stairs instead of the elevator, order a salad instead of a cheeseburger with French fries, or choose one method of contraception instead of another, they may be influenced, consciously or unconsciously, by epidemiologists' assessment of risk.
- Since World War II, epidemiologists have provided information related to all those decisions. In the 1950's, epidemiologists documented the increased risk of lung cancer among smokers; in the 1960's and 1970's, epidemiologists noted a variety of benefits and risks associated with different methods of birth control; in the mid-1980's, epidemiologists identified the increased risk of human immunodeficiency virus (HIV) infection associated with certain sexual and drug-related behaviors; and, more positively, epidemiologists continue to document the role of exercise and proper diet in reducing the risk of heart disease.

- **Completing the clinical picture.** When studying a disease outbreak, epidemiologists depend on clinical physicians and laboratory scientists for the proper diagnosis of individual patients.
- They also contribute to physicians' understanding of the clinical picture and natural history of disease. For example, in late 1989 three patients in New Mexico were diagnosed as having myalgias (severe muscle pains in chest or abdomen) and unexplained eosinophilia (an increase in the number of one type of white blood cell). Their physician could not identify the cause of their symptoms, or put a name to the disorder. Epidemiologists began looking for other cases with similar symptoms, and within weeks had found enough additional cases of eosinophilia-myalgia syndrome to describe the illness, its complications, and its rate of mortality.

- Epidemiologists have documented the course of HIV infection, from the initial exposure to the development of a wide variety of clinical syndromes that include acquired immunodeficiency syndrome (AIDS).
- They have also documented the numerous conditions that are associated with cigarette smoking—from pulmonary and heart disease to lung and cervical cancer.

- **Search for causes.**
  Much of epidemiologic research is devoted to a search for causes, factors which influence one's risk of disease. Sometimes this is an academic pursuit, but more often the goal is to identify a cause so that appropriate public health action might be taken. It has been said that epidemiology can never prove a causal relationship between an exposure and a disease. Nevertheless, epidemiology often provides enough information to support effective action. Examples include;
  - John Snow's removal of the pump handle and the withdrawal of a specific brand of tampon that was linked by epidemiologists to toxic shock syndrome.
  - Just as often, epidemiology and laboratory science converge to provide the evidence needed to establish causation. For example, a team of epidemiologists were able to identify a variety of risk factors during an outbreak of a pneumonia among persons attending the American Legion Convention in Philadelphia in 1976. However, the outbreak was not "solved" until the Legionnaires' bacillus was identified in the laboratory almost 6 months later.

PART II

The Epidemiologic Approach

Epidemiologist determines *What, When, Where, Who, and Why*. However, the epidemiologist is more likely to describe these concepts in slightly different terms: **case definition, time, place, person, and causes.**

Case Definition

A **case definition** is a set of standard criteria for deciding whether a person has a particular disease or other health-related condition. By using a standard case definition we ensure that every case is diagnosed in the same way, regardless of when or where it occurred, or who identified it. We can then compare the number of cases of the disease that occurred in one time or place with the number that occurred at another time or another place.E.g. with a standard case definition, we can compare the number of cases of hepatitis A that occurred in City A in 1991 with the number that occurred there in 1990. Or we can compare the number of cases that occurred in A in 1991 with the number that occurred in B in 1991

Descriptive Epidemiology

We organize and summarize data according to time, place and person. The three variables are called **epidemiologic variables.**

- **Time**
  Disease rates change over time. Some of the changes occur regularly and can be predicted. E.g. the seaconal influenza cases increase with the onset of cold weather is a pattern that is familiar to everyone. We usually show time data as a graph. The rates of cases or deaths are on the y-axis and we put time period on the x-axis.The limit of the period may be days, weeks, months or even years.
  The time when the number of cases is greater than normal is known as an **epidemic period**.some common types of time-relate graphs are:
  1. **Secular trends**: Graphing annual cases

The end