Part One

Fundamental Epidemiology

Chapter 1

one

Introduction

1. What is epidemiology?

Epidemiology is a fundamental medical science that focuses on the distribution and determinants of disease frequency in human populations. If there is disease occurring in the population, we always want to know the cause or the trend of the problem. Who is developing a disease, and where and when, and why are they developing it? We like to be able to compare the disease distributions in different places, different years and in different groups of people. We want to know what is the possible cause of the occurrence of the disease. Based on this knowledge, we may take some measures to control or prevent the disease. Some very common questions are, for example:

- how many new cases with flu occurred last year in this country and how many cases this year.
- if we immunized the population with vaccine, does it prevent the epidemic of flu or not.
- how many cases with diabetes now in this community?
- what is the trend of the breast cancer among women in the urban and rural areas.

Epidemiological methods may help us to answer these questions. Epidemiology is also important to the practice of medicine as increased knowledge of disease occurrence aids in diagnosis and treatment.

The term epidemiology consists of the Greek words *επι* (epi) = among, *δημοζ* (demos) = people, and *λογοζ* (logos) = doctrine. It was translated as "a statement of what is upon the people". Therefore epidemiology is a human science and it concerns the health problems in the human population. (WHO, 2002)

Definition of epidemiology

There are many definitions of epidemiology in the literature. Here is the definition from the Dictionary of Epidemiology, edited by Dr. Last, which seems to well describe the work of epidemiology:

"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 control of health problems." (Last, 2002)

2. Brief history of epidemiology

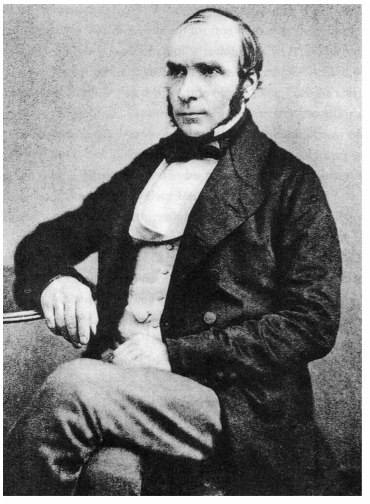
In the history of human beings, many epidemic or pandemic diseases were spread in the population such as plague, small pox, cholera, leprosy, syphilis, etc. which caused numerous deaths or serious social problems. It was estimated that there were over 60 million people died from plague in the world. (Oleckno, 2002) Up to the early 20th century, more than 600 epidemics had been documented in China. (Geng, 1996) The people always attempted to find the reasons why these diseases occurred and were trying to control the spread of the diseases. These efforts contributed to the development of epidemiology.

2.1 Early epidemiology

The development of epidemiology occurred over a long stretch of time and numerous doctors and persons contributed to its progress. Many epidemiological observationswere made. Today these observations may seem simple or not critical in design, but they provided very useful information towards describing diseases and their control. Even though microorganisms were not identified until the 19th century, the people found that the diseases might be infectious and spread from person to person or from animal to person. Gradually the people knew that the isolation of the ill people might control the transmission of the disease. In 14th century, in Europe the ships were asked to stay in an isolated area before arrival into the port for 40 days to protect the community against the Black Death (plague), this is the origin of the quarantine. People knew more and more about the possible route of transmission of disease and invented some control methods for disease, such as the vaccine to prevent smallpox (by Edward Jenner, 1749－1823). In fact, the process of the fight against disease led

to the development of epidemiology.

Hippocrates, the physician who lived about two thousands years ago, was often mentioned as the pioneer of epidemiology. In his books he described the epidemics of disease and recognized associations between environmental and other factors and certain diseases.



John Snow

For the collection of health data, such as mortality of the population, the UK medical registration of death is a good example that was introduced in 1801, and in 1838 William Farr (1807－1883) introduced a national system of recording causes of death. The analyses of these data involving such techniques as life tables and the standardization of rates gave a picture of the health status of the population of Great Britain.

As we learned the history of epidemiology, **John Snow's work and the Broad Street pump story** is a very common example to show the contribution of epidemiologyon the control of the disease. Dr John Snow (1813－1858), was a surgeon (actually an anesthesiologist) and pioneer of the science of epidemiology. The work of John Snow is generally quoted as an example of a brilliant analytical investigation which can lead to the identification of a pathogenic agent and its elimination from the environment.

The first epidemic of cholera hitting Great Britain was in 1831－1832 and caused at least 60,000 deaths. Dr. Snow directly investigated the subsequent major epidemic episodes in London in 1849 and 1854, focusing attention on the role that polluted water might have played in the spread of the disease.

In the 1854 London epidemic, the worst-hit areas first occurred in the districts supplied by the Southwark and Vauxhall Water Company. At the same time, there was a markedly smaller number of deaths in those districts supplied by the Lambeth Company. Because in some areas the water supplies for the two companies happened to be closely intermixed, Dr Snow carried out a door to door inquiry to ascertain to which company supplied the water to their homes. The results clearly demonstrated the association between water supply and later the deaths from cholera. When they calculated death rates from cholera, for the districts supplied by Southwark and Vauxhall it was 4.4 per thousand population, but for the districts supplied by the Lambeth company it was only 0.2 per thousand. There was more than a 20 times difference.

There were also many other factors that led Snow to isolate the cause of the cholera to the Broad Street pump which belonged to the Southwark and Vauxhall Company. For instance, of the 530 inmates of the Poland Street workhouse, which was only, round the

The pump handle
(Source: Steven Johnson, Ghost Map, Riverhead Books, New York, 2006)

corner, only five people had contracted cholera; but no one from the workhouse drank the pump water, for the building had its own well. Among the 70 workers in a Broad Street brewery, where the men were given an allowance of free beer every day and so never drank water at all, there were no fatalities at all. And an army officer living in St John's Wood had died after dining in Wardour Street, where he also had drunk a glass of water from the Broad Street pump.

Though the authorities were reluctant to believe his conclusion, they agreed to remove the pump handle as an experiment. When they did so, the spread of cholera dramatically stopped.

It is very interesting that even though John Snow by 1854 concluded that cholera could be transmitted through contaminated water, the etiologic agent of cholera, Vibrio cholerae, was not identified until almost three decades later. Dr. Snow had proved the cause of the cholera epidemic in Broad Street, London and controlled it by stopping the water supply from the suspected pump was before the development of the theory of disease caused by microorganisms.

Later in the 19th century, some bacteria were recognized by some scientists such as Louis Pasteur in France and Robert Koch in Germany. They demonstrated that microorganisms could cause infectious disease, and developed the criteria to judge the relationship between the microorganism and a specific disease. Along with the progress of microbiology and techniques of statistics, epidemiology began its rapid evolution. There was the first association of epidemiology in London in 1850 and there was even a journal on epidemiology in Russia in 1870. (Geng G)

2.2 Modern epidemiology

For traditional epidemiology, most of the work was concentrated on infectious diseases, such as plague, small pox, cholera, typhoid fever. It was reasonable because epidemics or pandemics of these infectious diseases historically caused millions of deaths. This led to authorities and health workers trying to find the cause of such diseases and to control the spread or eliminate the diseases from the world. Later there were also some individuals who contributed great work on non-infectious diseases such as the identifying of causes and control for pellagra, scurvy, beriberi, etc. In fact James Lind (1716 −1794) had identified the dietary factors associated with scurvy in 18th century

and found the way to prevent and treat the problem, and it eventually led to the development of experimental epidemiology.

Around World War Ⅱ and later, there were some epidemiological studies on non-communicable chronic diseases such as cancer and cardiovascular disease. A very good story is about smoking and health issue. There were a couple of studies published in the United States and in the United Kingdom in the late 1930's. Doll and Hill in UK had carried out a series studies including case-control study and prospective cohort studies. The air pollution was very serious in London and people thought it could be the main cause of the increase mortality from lung cancer. However the studies of Dr. Doll and his colleagues suggested a very significant association between cigarette smoking and lung cancer. The Framingham heart study in the US is another classical example, it was started in 1948 when heart disease had become an important cause of death of the population in the United States.

Today, epidemiological methods of investigation have become tools for answering the questions in medicine and public health regarding their biological and social facets. Especially due to the progress of the use of computers, analyses of large databases and complicated calculations have become feasible. Epidemiology has contributed to the understanding of diseases in the population, the studies of etiology, and control of some health problems including preventive or therapeutic actions for a lot of important diseases e. g. cardiovascular diseases especially ischemic heart disease, asthma, and some cancers. Regarding the identifying of the possible causal risk factors for some emerging diseases such as AIDS, Legionnaires' disease, Lyme disease, and *Helicobacter* infections, epidemiology has played a significant role.

Epidemiological methods have been applied in various areas or jointly with other disciplines and there have been many branches of epidemiology emerge in recent decades such as cancer epidemiology, cardiovascular epidemiology, or sero-epidemiology, pharmacoepidemiology, clinical epidemiology, molecular epidemiology. All of these applications are based on epidemiological methods, the basic principles we will learn in this book.

3. An overview of methods of epidemiologic studies

To answer the questions about disease distributions, trends of the diseases, etc., we need to collect data from the population and then describe the data or analyze the relationship between the exposure and outcome or cause-and-effect association. **Exposure** is a very common used term in epidemiology, it refers to the causal

factors that may associated with the disease. For example, contact with a biologic agent, a harmful materials, or some characteristics such as the age or blood groups which may put an individual at increased risk. Exposure may of course be beneficial rather than harmful, e. g., exposure to proper physical exercise. **Outcome** is the disease or other change in health status. It is the possible result associated with the causes, risk factors or preventive measures. In epidemiology, we collect data about the exposure and outcome and then describe them and/or analyze the association between them.

3.1 How to describe the disease in the population? Person, place, and time

Firstly we need to know the distribution of the disease. Primarily it refers to how the morbidity (incidence and prevalence of the disease) or mortality is distributed in a given population or a community. Generally we describe morbidity (illness) or mortality (deaths) in terms of **person, place and time.** We want to know what is the rate of illness in different age groups, whether they have the same death rates, whether there is a difference among various countries, and what are the trends of the pattern of death in the last decades. By this description we may have the idea of disease in the population and furthermore it is possible to explore or find the potential causes of the disease distribution.

3.1.1 By person

Age, sex, race group, education, occupation, socioeconomic status, marital status, immunization status and some lifestyle or behavior habits are common variables used to describe the distribution of disease. For example, we might describe the distribution of coronary heart disease in one community by sex, age, occupation, and some lifestyle factors such as smoking, drinking and physical exercise. These descriptions may give us a very good idea of this disease. These data will be very useful for the estimate the burden of the disease and policy making. These descriptions may also provide us some thinking of who are in the risk group and what is the potential reason of the disease. More detailed examples of distribution of disease by person will be seen in the chapter of communicable diseases.

3.1.2 By place

Place variables include various geographic characteristics. They might be based on administrative areas such as countries, provinces, cities, towns, or neighborhoods, or

might be based on specific geographic characteristics such as urban and rural area, mountainous area and plain district, or in different latitude or altitude. For example, Figure 1-1 gives us the idea of the liver cancer death rates are varied among countries and districts. And Figure 1-2 is the distribution of esophagus carcinoma in Taihang Mountain area, a central place in China where the death rates of this disease were high. The description of the distribution might be very helpful for the etiological study of this cancer.

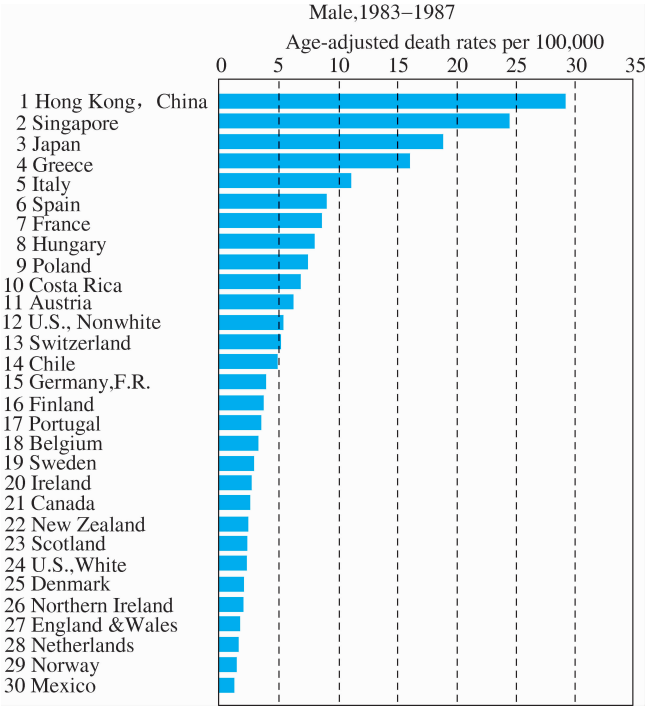


Figure 1-1 Age-adjusted death rates of malignant neoplasm of liver and intrahepatic bile ducts (Males) in selected countries and districts (1983 – 1987)
(Source: Tominaga S., Kuroishi T, Aoki K. ed: Cancer mortality statistics in 33 countries and districts 1953 – 1992. UICC 1998, p. 50)

3. 1. 3 By time

"By time" refers to the distribution of given disease by hours, days, weeks, months, years, or even by decades. From the description it will reveal the temporal patterns of the disease. We might know the trends of the disease or some change that is unexpected. Common temporal patterns of morbidity and mortality include short-term fluctuations, cyclic changes and secular trends.

Short-term fluctuations refers to relatively brief, unexpected increases in the frequency of a particular disease. Short-term fluctuations are commonly manifested in epidemics.

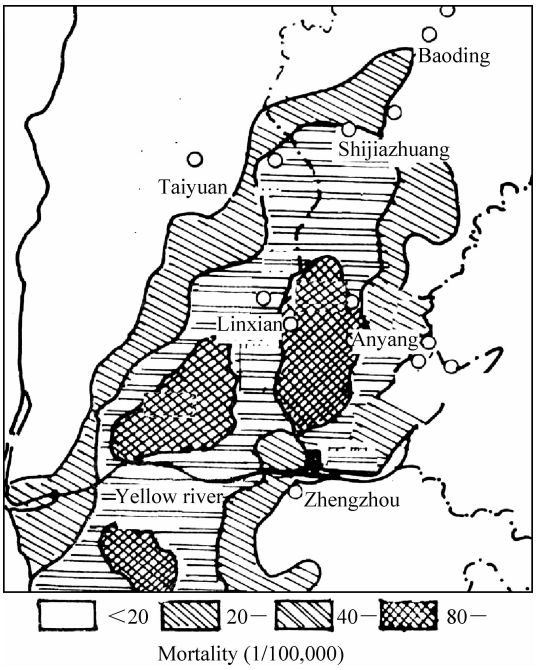


Figure 1-2 Mortality of esophagus carcinoma in Mountain Taihang area, China, 1979 (Source: Geng G, 1996)

Cyclic trends represent periodic increase in frequency of a particular disease morbidity or mortality. It often is predicable.

Seasonal variation is a typical cyclic pattern. The morbidity or mortality of a particular disease might be influenced by weather or temperature. Many diseases have this phenomenon, including infectious disease and non-infectious chronic diseases. The examples for infectious diseases are malaria, influenza, and the examples for non-infectious diseases are some cardiovascular diseases such as stroke.

However, cyclic trends are not only seasonal variations. The curve of time distribution of some illness might have elevation every other year or with an interval of several years. For example measles, before the wide use of vaccine for the immunization, epidemics were common in the community at two or three years intervals. The assumed reason is of the accumulation of susceptible children. The same phenomenon may also be found in the distribution of hepatitis A in some places.

Secular trend is also called long-term changes. It represents the pattern of trends for a long time such as many years, decades, or even centuries. From Figure 1-3 the data shows us that female breast cancer has been increasing in most countries even though the rates are varied. Figure 1-4 is the trends of incidence and mortality of infectious diseases in China from 1980 to 2000. We can know both incidence and mortality have decreased dramatically.

Table 1-1 summarizes the commonly used variables of person, place and time.