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Epidemiology

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Accepted as a textbook for
the students of clinical
and pediatric departments
of medical institutes

MOSCOW
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GENERAL EPIDEMIOLOGY

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SPECIFIC EPIDEMIOLOGY

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General Epidemiology

THE SUBJECT AND TASKS OF EPIDEMIOLOGY

The Subject of Epidemiology. Epidemiology deals with infectious, or, in a broader sense, communicable diseases of man. These diseases differ essentially from other pathological conditions affecting human beings in that they are caused by living organisms—bacteria, protozoa, fungi, viruses, helminths and arthropoda which are parasitic on and pathogenic for man. The organisms causing communicable diseases in man are the subject of study by many branches of biological and medical science (microbiology, virology, helminthology and others); however, epidemiology studies certain aspects of the existence of these organisms—for example, why and how certain biological species became the pathogenic agents of human diseases, what peculiar features in man's social life and activities promote the existence of these organisms at the present time. These questions are largely of an ecological nature and therefore *epidemiology might be defined as the ecology of the pathogenic organisms of communicable diseases in human society.*

This definition, however, by no means exhausts the subject-matter of epidemiology. A communicable disease occurs as a result of the interaction between the pathogen and the human organism under specific environmental conditions. This interaction is the essence of the infectious process studied by many branches of medical science (general pathology, immunology, clinical study of infections, etc.). Some questions in the theory of infection have a direct bearing on epidemiology. For example: what is the route the pathogen takes on entering or leaving the organ-

ism; what is the degree and duration of immunity acquired after an infection? We may, therefore, also define *epidemiology as a science dealing with the mechanisms involved in the occurrence of communicable diseases in man.*

This definition, too, fails to cover the subject-matter of epidemiology completely, since specific infectious diseases do not exist in isolation from one another, but are closely interconnected. To illustrate this we may cite three examples—a case of measles in a kindergarten, group food-poisoning, and several cases of brucellosis in a community. Measles occurred after a child had been in contact with an infected person; food-poisoning occurred after a group had eaten insufficiently boiled meat contaminated with salmonellae; cases of human brucellosis appeared after contact with cattle infected with brucellae or after ingestion of brucella-contaminated dairy products. In all these instances, it is possible to establish the causes linking these specific cases of disease. Therefore, *epidemiology may also be defined as a science dealing with the means whereby infectious diseases spread amongst human beings.*

This definition, too, does not cover the entire field of epidemiology. A knowledge of the means by which influenza spreads does not serve to explain the widespread epidemics, or even pandemics, of this disease which occur from time to time, such as the pandemic of 1957, which involved approximately one thousand million people. Likewise, a knowledge of the means by which poliomyelitis spreads is not sufficient to account for the steady and general increase in the incidence of this disease during the first post-war decade. All of these questions must be answered by epidemiology, which may also be defined as a science *studying the causes of the outbreak and subsidence of epidemics.*

Even this does not exhaust the tasks confronting epidemiology. Since it is not only a science but is also concerned with practical activities, it elaborates prophylactic measures for the control and prevention of infectious diseases based on the scientific study of the previously numerated subjects.

Epidemiology is thus the science of the laws governing the appearance and spread of communicable diseases in

human society and of prophylactic measures designed to prevent them.

This definition of epidemiology as a branch of medical science and as an aspect of man's practical activities indicates its connection with other sciences and the system of public health services. These sciences are, first, microbiology (including virology and immunology), parasitology, epizootology, general pathology, the clinical study and therapy of infectious diseases, a number of special clinical subjects (surgery, venerology, dermatology, and others), as well as various aspects of hygiene. Epidemiology comes within the purview of public health services as it is closely connected with applied hygiene (sanitary-epidemiological matters) and occupies a prominent place in the practical activities, not only of epidemiologists and specialists in infectious diseases and hygiene, but also of therapeutists, pediatricians, obstetricians, gynecologists and surgeons, as well as more specialised branches of medicine.

The Methods of Epidemiology. Epidemiology has its own methods of investigation, and at the same time also makes wide use of methods employed by other sciences.

The principal methods of epidemiological investigation are the *epidemiological survey and epidemiological experiment.* The epidemiological survey may be concerned with one case, a group of cases, an outbreak of disease or an epidemic and, finally, it may be concerned with a definite territory and be conducted for a more or less lengthy period of time. The epidemiological survey aims at obtaining data necessary for understanding the causes of the appearance of diseases and for elaborating measures to stop their spread. Usually, in addition to the information obtained by the physician from the patient and his contacts and from a visit to the patient's house and place of work, other investigations must be undertaken: namely, microbiological, serological, clinico-diagnostic (in order to establish a correct diagnosis and ascertain the presence of infection in the patient's contacts), hygienic (to determine the possible role played by water, food and other environmental factors in the transmission of the disease), statistical (in cases of an outbreak on a mass scale), epizootological and parasitological (in cases of infection transmitted by domestic

and wild animals), etc. The scope and nature of an epidemiological survey (as well as of the additional methods of investigation) vary with the diagnosis of the disease, the number of cases and the conditions under which the disease occurs. On the basis of the results of an epidemiological survey, practical measures are instituted to prevent the occurrence of the disease or its further spread.

The epidemiological experiment is employed to test the effectiveness of one or another method of disease control. Following laboratory tests, prophylactic vaccines, sera or antibiotics are put to the final test by epidemiological experiment. This also applies to any other method of combating infectious diseases—isolation, disinfection, segregation, etc.—the effectiveness of which may also be judged by epidemiological experiment. A sufficiently large group of people, living as far as possible under similar conditions, is carefully selected for purposes of epidemiological experiment. This group is usually divided into two numerically similar groups; the trial group is subjected to the action of the factors being tested, while the control group is not. The effectiveness of this factor is then determined by a comparison of the incidence of disease in the trial and in the control groups after a statistical analysis of the results of observations made on both groups.

Surveys and experiments are not the only methods of investigation used in epidemiology. Statistical analysis of the incidence of infectious diseases is of especial importance. The majority are distinguished by seasonal distribution, different reactions of various age groups, some infectious illnesses mainly affecting children, and also the uneven geographical incidence of diseases. A comparison of statistical data collected over a period of several years will show the tendency of a disease to decrease or increase in incidence, or to fluctuate periodically. All these data are indispensable for the correct planning of measures to control and prevent infectious diseases. Working without the aid of statistics in epidemiology is tantamount to working in the dark.

The method of comparative-historical analysis in epidemiology is used to study the evolution of infectious diseases,

the distinctive features of epidemics in various historical epochs, their connection with the socio-economic structure of human society, etc. The method of comparative-historical analysis is also extremely important in evaluating the possibilities of stamping out a given infectious disease.

Epidemiology makes generous use of the methods of investigation employed by allied disciplines—microbiology, general pathology, parasitology, etc., and these methods are frequently instrumental in solving purely epidemiological problems—for example, establishing the required isolation period for an infectious patient, determining the routes of transmission of an infectious disease, discovery of a vector of an infectious disease, etc.

Epidemiological methods of investigation are, in their turn, used in other fields of medical research. Recently, these methods have come to be employed in investigations of non-infectious diseases: cancer, hypertension, cardiovascular diseases, etc. Sometimes we even hear the expression "the epidemiology of non-infectious diseases" applied to the incidence of cancer or atherosclerosis in different age or occupational groups of the population, or when attempting to elucidate the effect of living conditions on the incidence of such diseases. Clearly, the use of epidemiological methods of research in the study of non-infectious diseases, while quite justified, does not imply an expansion of the subject-matter of epidemiology as a science and, therefore, the use of the term for other purposes is purely optional and cannot be considered as strictly scientific.

A Brief History of Epidemiology. Epidemiology is both a very ancient and a comparatively young science. It may be considered old because even in ancient times, when mankind was faced with communicable diseases, people began to work out primitive methods of combating them. It may be considered a young science because its real development started with microbiology, after the great discoveries made by Pasteur and other scientists of that period.

Although in ancient times infectious diseases were ascribed to the work of demons, many anti-epidemic measures were worked out empirically. For instance, variolation

(artificial smallpox inoculation) was used in China about 1,000 B. C., and in India, round about the same time, avoidance of contact with rats was recommended in order to lessen the risk of plague, while in a number of Asian countries, lepers were banished from the community.

The level of culture of both ancient Greece and Rome made possible the understanding that live contact with disease was a cause of epidemics. This concept, met within the works of Hippocrates (5th-6th centuries B. C.), was further elaborated by Lucretius (1st century B. C.). These generalisations were based on observations of numerous epidemics which occurred in the ancient slave states (Hippocrates wrote a special book on epidemics).

This same idea was prompted by the outbreaks of epidemics of grave infectious diseases that occurred during feudalism, especially in the 14th and 15th centuries, when epidemics of plague, smallpox and typhus fever assumed devastating proportions. It was during this period that the concept of the live contact as the cause of communicable diseases was clearly formulated in the works of outstanding physicians—the Veronese Fracastoro (1483-1553) and the Englishman Sydenham (1624-1689). Quarantine and other anti-epidemic measures were introduced at that time, after their effectiveness had been confirmed by practical experience.

The Industrial Revolution and the development of capitalism lent an impetus to the development of many sciences, including the science of epidemiology, because the inception of this new socio-economic formation was accompanied by outbreaks in city slums of epidemics of intestinal infections, parasitic typhus fevers and tuberculosis, and by the appearance of new diseases in European countries (cholera and yellow fever). At the end of the 18th century Jenner (1749-1823) discovered a method of preventing smallpox by inoculation with vaccinia (cowpox).

It was during this same period that epidemiology arose as a science in Russia where, after the reforms introduced by Peter the Great, economic development began making fast progress. Increased contacts with other countries, as well as wars, were instrumental in introducing plague,

typhus fever, smallpox and other diseases into Russia. One of the first Russian epidemiologists, Danila Samoilovich (1724-1810), convinced that the pathogenic agents of communicable diseases were living organisms, tried to discover them with the aid of the microscope. He helped to combat an epidemic of plague in Moscow (1771-72), organised a quarantine service in the Black Sea coast area, fought in the wars and won world-wide recognition for his works on epidemiology.

Epidemiology was given a new basis and a colossal impetus following the discoveries of Louis Pasteur (1822-1895), Robert Koch (1843-1910), Ilya Mechnikov (1845-1916) and their followers, who proved the microbial etiology of infectious diseases. A knowledge of the pathogens of infectious diseases not only made possible an exact study of their epidemiology but also provided medicine with new weapons in the fight against disease—vaccines and sera.

Amongst the Russian scientists who contributed to the development of epidemiology, mention must be made of G.N. Minkh (1836-1896) and O.O. Mochutkovsky (1845-1903). These scientists infected themselves with relapsing fever and typhus fever and established the presence of the pathogenic organisms of these diseases in the blood stream. They rightly concluded that these diseases were transmitted by blood-sucking insects. The name of Ilya Mechnikov is associated with the modern concept of susceptibility and immunity to infectious diseases. The discovery of viruses is the achievement of D. I. Ivanovsky (1864-1920). S. P. Botkin (1832-1889) was not only an outstanding specialist in internal and infectious diseases, he was also an epidemiologist whose ideas on the nature of infective hepatitis were years ahead of those of his contemporaries. P. F. Borovsky (1863-1932) discovered the pathogenic agent of leishmaniasis (1898), a disease subsequently named after the English scientist Leishman. Mention should also be made of the research done by B. K. Vysokovich (1854-1912) in the field of plague epidemiology, by G. N. Gabrichevsky (1860-1907) on diphtheria (serotherapy) and scarlet fever (streptococcal etiology), by I. G. Savchenko (1862-1932) on cholera (enteral immunisation), etc. N. F. Gamaleya (1859-1949) is