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FROM WITCHCRAFT TO WORLD HEALTH
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GENERAL INTRODUCTION

There have been striking changes in the incidence of infectious diseases in England and Wales. Cholera, typhus and the plague have been banished entirely, and diseases such as enteric fever, smallpox and diphtheria virtually so. Measles and scarlet fever have lost their sting and are no longer the main killers of young children. How far these changes are due to direct human intervention in the battle against germs and how far to changes in the virulence of the germs or in the resistance of the human organism has not been determined. It is clear that there is no simple answer. Improved sanitary conditions account for much of the disappearance of typhus and cholera, and for the striking decline in typhoid, but there must be other factors as well. Contaminated water is not uncommon in some rural areas in England and Wales, and the typhoid bacillus can be traced in sewage, yet there are no widespread outbreaks of enteric fever to-day ; the human louse is still encountered as a parasite in many districts, but no longer seems to carry the deadly rickettsiæ to man.

Direct human intervention has played an important role in the battle against epidemics. With the discovery of the part played by germs, measures could be taken to prevent their spread, by recognizing which were pathogenic and the specific illnesses they caused, tracing their paths of attack on man, and destroying them before they could reach the body ; for example, by purifying water, protecting milk and food, removing sewage, refuse, dust and dirt, and destroying insect carriers of germs. These measures undoubtedly reduced the number of outbreaks, and were also useful in preventing the spread of individual epidemics.

However, the problem of the human carrier of pathogenic germs complicated the picture. Some people attacked by the germ were overcome and contracted an illness ; some, on the other hand, could ward off the onslaught of the germs but carried them in their body alive and dangerous to others; and still another group, with only a mild illness and remaining ambulant, readily transmitted germs to others.

Measures taken to prevent the spread of germs by cases and carriers included isolating frank cases and disinfecting their articles and surroundings, and tracing carriers, missed and mild cases. But we do not know yet why some people contract an illness and others do not when they come in contact with the germs under similar conditions, and attempts have been made to increase the resistance of the human organism against germs artificially by vaccination and immunization. But, here again, there are many other factors involved. For example, diphtheria immunization has played a vital part in the conquest of diphtheria, but better social and domestic conditions, the smaller size of families, a better diet and acquired immunity have also made a substantial contribution.

It is clear that all available weapons must be used in the battle against germs, and in particular not to rely on the simpler ones alone. As Greenwood said : "It is a great deal better to provide clean houses and food than to pre-immunize people against the possible consequences of dirty houses and food, leaving the environmental conditions alone."[1]

Greenwood studied the evolution of epidemics and contributed much to our knowledge of crowd diseases, setting out the main principles of controlling epidemics.[1] He recognized that it is impossible to reduce infection by quarantine alone, and that pre-immunization is only partly successful in the battle against the germs. In a large herd the regular introduction of susceptibles confers a herd immortality on the illness, but the rate of mortality from infection decreases as the unfit are weeded out and immunity is acquired by the remainder. Active immunization is probably more important than selection. The evolution of an epidemic depends on the proportion of the groups (and sub-groups) of the clinically ill, the sub-clinically infected members and those not infected, but we do not know how far the proportion of these groups influences the spread of infection. The sudden addition of a large number of susceptibles to an infected herd appears to have a slighter effect on the spread of illness than the regular supply of smaller numbers. The studies of Greenwood have been extended by many others, and in particular by Burnet.[2]

However, there are many gaps in our knowledge of the evolution of epidemics. Recent work on the seasonal susceptibility of animals to infection, and with experimental changes in hormonal equilibrium, have brought again into prominence the role of climate and cosmic conditions, which previously had fallen into disrepute with the discovery of germs. The pattern of epidemics in England and Wales is changing, and it is probable that in the same way as many infections prevalent in the past are no longer present to-day, many of the infections of to-day were not present in the past. How far this position has arisen by changes in the invasiveness and virulence of the parasite and in the receptiveness or resistance of the host is not known. The causes of the changes are very complex, but the more we learn about them the more opportunities we have of controlling them and increasing the effect of direct human intervention in the control of epidemics.

The study of individual epidemics is also of great importance. There is no such thing as a "text-book epidemic"; the more one examines outbreaks, the more one understands how much more there is to learn, but each outbreak, with its own characteristics, always has some lessons to help us tackle the next one. The following pages describe some outbreaks of diseases which were more prevalent in the past, as well as some which have recently become more common. Modern methods of living have reduced the hazards from such diseases as cholera and typhus but have increased the risk of others such as food poisoning associated with communal feeding and the manufacture of foods on a large scale, and the spread of infection by faster means of travel. Modern civilization has also brought much more enlightened population, and no outbreak can be successfully tackled without full co-operation from the public and bodies such as the Press and the B.B.C. The more the public learns about outbreaks now, the less misunderstanding and difficulties will be encountered when they are involved in an outbreak.

The outbreaks described in the following pages have not been chosen because they are either representative or typical. They have been divided into three groups caused by viruses, bacteria and inert poisonous substances.

The virus diseases are headed by smallpox, a disease which illustrates that although our knowledge of viruses is relatively recent, diseases caused by them are very ancient. A large amount of space has been devoted to smallpox, because this disease has important features common to all infectious diseases, and from a practical point of view can still be a serious danger if imported unexpectedly, as often happens. Poliomyelitis is described next because of its recent prevalence, which has stimulated much work on its evolution and control, providing information useful in other virus infections. Finally, the psittacosis, Q. fever and Bornholm infections are described. Their study, because they often produce vague syndromes, also helps to throw light on many illnesses that to-day either go undiagnosed or have an indefinite diagnosis attached to them.

The bacterial group is headed by enteric fever, which, although still declining in incidence, still presents many interesting problems. The intensive study of the restricted outbreaks of to-day is providing most useful information on the general evolution of infectious diseases. The food poisoning group has come into prominence in the last few years, and each new outbreak brings more knowledge on how to avoid the spread of infection in the future. Diphtheria is described because, although it is definitely on the wane, it can still produce serious problems. Also, new measures of investigation and control have to be adopted in the relatively small outbreaks of diphtheria to-day.

The two last outbreaks to be described, caused by lead and smog, illustrate some of the newer problems in an industrial society. The method of approach is of course somewhat different from that in the battle against germs, but the general epidemiological investigation and control have many similarities, particularly in the enlisting of different groups in the community in the battle against substances and conditions which are inimical to health.

This book is directed mainly to medical men, and all health workers, who have to be constantly on the alert for any illness or condition which may be of an epidemic nature. It is also essential that some knowledge of outbreaks is presented to the public.

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INTRODUCTION : VIRUS DISEASES

VIRUSES are now playing a leading role in the drama of man's battle against the infectious diseases. This is not because they have only recently appeared as dangerous enemies changing the face of history. Already viruses, such as smallpox and measles, and rickettsia, such as typhus, have played an important part in the downfall of empires, and in stimulating reforms in insanitary towns. To-day, poliomyelitis is the only new virus disease which strikes terror, even though it cannot have the profound social and economic effects as other virus diseases had in the past. However, influenza, a disease which killed more people in the pandemic of 1918 than were killed in military operations in the whole period of the 1914–18 war, is still present and ever ready to strike again. The common cold, causing great loss to the national economy, still eludes the epidemiologist, and measles still affects most children. Virus diseases, such as Q. fever, psittacosis, and Bornholm disease, which appear new, raise important questions : how long they have plagued mankind, how prevalent they are to-day, and how they evolved. Their relation to atypical primary pneumonia and the many forms of aseptic meningitis has yet to be determined. Perhaps equally important in elevating the virus to this new role are the bacteriologists, who have almost exhausted the possibilities of examining the many characteristics of bacteria, and are therefore now turning to using the new methods for studying the fascinating world of viruses.

The infinitely small as well as the infinitely large have always intrigued man and stirred his imagination. However, the mystery surrounding the viruses is gradually being penetrated and they appear to be no more than small germs ; yet there are marked differences between them and ordinary germs.

They were first considered when bacteria could not be isolated from diseases, such as measles and smallpox, which were obviously infectious, yet behaving like diseases such as scarlet fever and diphtheria, where specific bacteria had been isolated. Pasteur correctly surmised that rabies was caused by an ultramicroscopic microbe when he could not isolate a specific germ. At the end of the nineteenth century the first organisms were discovered which could pass through a filter with pores small enough to retain bacteria. The discovery of a filter-passing organism which caused mosaic disease of tobacco was soon followed by another which caused foot and mouth disease.

To-day, with the discovery of the electron-microscope, the terms ultramicroscopic and filter-passing become academic. It might be interesting to speculate what classification of microbes would have been made if the microscopes which were first used for their definition were more powerful. Clearly, although size is a factor in their differentiation, it is not vital in determining the differences between microbes. There is a greater difference between the largest and the smallest virus than between the smallest bacteria and the largest virus. The staphylococcus, measuring 1,000 mu (mu = millionth of a millimetre), is only about four times as big as the psittacosis virus (220 to 230 mu), which itself is only slightly smaller than the rickettsia (300 mu), but is at least ten times as big as the poliomyelitis virus (13 to 20 mu). The smaller viruses are only twice as big as a serum globulin or serum albumin molecule (6 mu).

However, because of their small size approximating to that of molecules, there has been much speculation of their nature, whether they are living or not, and how they emerged. It has been suggested that there is a direct connection between the bacteria and the viruses through the rickettsia which are intermediate in size. Germs vary not only in size but also in their complexity of structure and their requirements for growth and multiplication ; but they are differences of degree rather than of a fundamental nature. One main difference between the larger and smaller germs is the dependence of the smaller germs on living cells for their growth and multiplication. It has been suggested that the viruses are a further stage in the development of germs. The micro-organism begins to lose its independence as it begins to rely more on the cells of its host, and therefore loses some of its enzymes and decreases in size. The alternative hypothesis that bacteria developed from viruses implies that viruses were present at a time before there were higher forms of life, which at least to-day are necessary for their growth and development.

The origin and the mode of spread of virus diseases are probably similar to those caused by bacteria. Man as a hunter, and before he lived in communities, was probably infected secondarily from animals, but germs had very little opportunity of spreading in man, who though he hunted in groups did not congregate in large numbers. Later, when he adopted farming and lived in settlements, germs could become established in man, so that he became a primary host. A modern example perhaps is yellow fever. One form of the disease occurs in the jungles where monkeys are the primary host and the virus is carried by a jungle mosquito, which can also transmit the disease, although not commonly, to man. The other form of the disease is the urban type which affects man as the primary host, and the virus is carried by a mosquito which breeds in towns. It is possible that the urban type originated from the jungle form. Similarly, psittacosis may have reached the stage where the primary host is changing from bird to man; in recent outbreaks infection has spread from man to man.

If the virus is too deadly, and there has not been time for adaptation between host and parasite, the disease is severe and the mortality high ; the parasite dies with the host and may thus disappear, as, for example, with the disease known as the " sweating sickness " in the Middle Ages. If there is a gradual adaptation, the disease becomes milder, and the number of people with symptoms decrease, even though the parasite may be widespread in the community. The mode of spread is then similar to that of bacteria : the reservoir of the germs are carriers and those suffering from subclinical infections, and the virus is spread by direct contact, through the air in droplets, dust, food, milk or water, through inanimate objects, or through insects, which are not merely mechanical transmittors—they usually suffer from the disease themselves. Rickettsiæ are usually transmitted by insects but Q. fever is carried to man mainly through dust.

There are various factors responsible for producing an epidemic of virus diseases which are similar to bacterial ones : an increase in the number of susceptibles, increased movements of the population or in the number of insects, climatic changes, malnutrition or insanitary conditions. Changes in the virus probably play an important part as well. A relatively unstable virus may undergo changes by mutation producing one better equipped to invade man.

The methods of counter-attack on viruses are similar to those used in outbreaks due to bacteria. Disinfection plays a large part. Viruses are readily inactivated by moderate heat (56° to 60° C.), oxidizing agents such as potassium permanganate, hydrogen peroxide and formaldehyde, extremes of pH and ultra-violet light. They are, however, resistant to phenol, drying and freezing (− 70° C. is often used for their preservation). Many are resistant to ether ; poliomyelitis can be more easily isolated from the stools by adding ether, killing the bacteria, with the virus surviving.

Both active and passive immunization have been used against virus diseases. The classical examples of active immunization is vaccinia in smallpox, and Pasteur's anti-rabies immunization. Methods include either an avirulent variant or injection of the virus by a safe route ; for example, influenza and psittacosis viruses injected subcutaneously. Modification of virulence by formalin or ultra-violet light does not appear to be so effective. Passive immunization is not usually so effective in virus diseases, because it is usually given too late to affect the virus which has already become attached to the tissue cells ; but gamma globulin, which usually contains the antibodies against diseases, has been found effective in the treatment of measles. Immunization and the study of viruses have been developed more readily since methods have been devised of culturing the virus in the chick embryo and in tissue cells ; previously the virus could be studied only after animal inoculation.

A description is given of outbreaks of five virus diseases : smallpox, poliomyelitis, Q. fever, psittacosis and Bornholm disease. Smallpox is no longer the terror it was in this country, but it can still break out unexpectedly with devastating results. Four recent outbreaks are described at length, not only as lessons for possible future outbreaks, but also as important examples of general epidemiology in virus diseases. They demonstrate that despite knowledge gained over many years and the possession of a useful weapon in vaccination, there are still many difficulties in matching the forces of the community against those of the virus. Still more so in poliomyelitis, where there are greater gaps in the knowledge of the spread of the virus, and vaccination has not yet proved as effective as in smallpox. The two outbreaks described do, however, give an indication of measures of control that may be effective if adopted early in an outbreak. The outbreaks of the other three diseases suggest that many cases of atypical pneumonia and of vague illnesses at present undiagnosed may be due to one or other of these virus diseases, and a study of how the infection spreads would help to devise effective measures of control. The main danger is that the viruses causing these diseases at present producing only relatively minor disturbances may become adapted to produce serious illnesses.