CLINICAL PATHOLOGY IN GENERAL PRACTICE

INVESTIGATION OF OUTBREAKS OF INFECTION

BY

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No short article can adequately cover the whole of the investigation of epidemics of communicable disease, so a number of restrictions have to be introduced. I shall deal only with diseases that occur in Britain, and largely with diseases for which the laboratory can, in the present state of knowledge, give practical help. Moreover, since it is with the investigation of localized outbreaks of communicable disease rather than with widespread epidemics that the general practitioner is likely to be concerned, the discussion is similarly restricted.

It is convenient to recognize three sorts of outbreak: one in which a number of cases occur as nearly as may be simultaneously; one in which infection appears to be spreading through the community; and one in which the so-called "dropping" cases of a disease occur at intervals. None of these histories is pathognomonic of any particular method of spread, but the explosive outbreak is often due to massive contamination of a common foodstuff, and the dropping-case type of outbreak is commonly due to a chronic carrier of the infective microbe. These two sorts of outbreak are also those in which the general practitioner may be in the best position to assist—the explosive outbreak because he is the first on the spot and therefore best placed to secure material for laboratory investigation; the dropping-case outbreak because he alone may be in a position to recognize its occurrence and envisage the common contacts of the patients.

In the investigation of a suspected outbreak of infection there are several steps. The first is the establishment of a precise diagnosis in the suspected cases, and the second is the taking of a careful history of the patients and of the outbreak. In some cases these two steps—diagnosis and history taking—indicate so closely the source of infection that for practical purposes further investigation is superfluous. More often, however, the third step is an attempt to trace the source from which the latest batch of patients became infected. At the same time an attempt is made to discover other victims of the infection who have as yet shown no signs of disease; sometimes it is also possible to determine the susceptibility of contacts to the disease. Lastly, it may be necessary to try to find out how the infection was spread—by direct contact or by indirect methods such as food, drink, air, or fomites.

Diagnosis and History

An accurate diagnosis and an accurate history for the individual patients are the first requirements. In many cases the "diagnosis" may be the name of a well-recognized disease. In others, however, it may be a syndrome, observed to occur in epidemic fashion, but not yet widely recognized. In the latter group accurate definition of the syndrome is most important.

The history needs to include the dates of onset of the disease in each individual patient; details of his activities at the times when, judged from the ordinary incubation period of the disease, he must have been infected; and

details of his activities immediately before he fell ill, when he was probably already infective.

In addition to the history of the illness in individuals, we need to construct a history of the incident as a whole, and this has to take account of the persons who were not ill as well as those who were. It is important, especially in outbreaks that may be food-borne, to assess the number of persons exposed to infection, and in all kinds of epidemic a comparison of the attack rates in various groups of the population—different classes in a school, different ages, the two sexes, the various wards in a hospital—may often give a strong lead to the subsequent bacteriological investigations.

In some instances diagnosis and history may be all that is possible, for want of methods for cultivating the responsible microbes or other means of laboratory confirmation. Even so, it may be possible to infer the way in which the disease is spread and methods for its prevention.

However, there are numerous occasions when laboratory help is indispensable to the proper investigation and control of the epidemic. Laboratory help comes first in helping to establish the diagnosis of the disease, and at this stage it has two functions. The first is to put a precise name to the patient's illness—to convert the label of "P.U.O." to the diagnosis of typhoid fever, to distinguish the streptococcal from the non-streptococcal sore throat, to recognize the true virus influenza among the host of "flus." These distinctions can often, with experience, be made on clinical grounds alone, especially in the face of a general epidemic, but the laboratory should be able to make the distinction with more certainty and in the atypical cases. For this to be most useful the laboratory must be prepared to issue, and the practitioner to accept, preliminary reports which may be subject to some revision when the tests are complete.

The second function of the laboratory is the "type identification" of the infecting organism. In many cases the members of a species of pathogenic bacteria or viruses can be classified into a number of types which are stable under natural conditions. Then, if two patients are found to be infected with one species of microbe but of two different types, we can conclude that they became infected from different sources and are not part of one epidemic. If both are infected with one type they may well have acquired the infection from a common source, but the

TABLE I.—Microbes that Cause Epidemics and Can be Classified Into Types

Microbe	Disease	Typing Method Employed on Microbe
<i>Salmonella typhi</i>	Enteric fever	Bacteriophage
<i>paratyphi</i>		
Other <i>Salmonella</i> species	Food-poisoning	Serology
<i>Escherichia (Bacterium) coli</i>	Some gastro-enteritis in infants	"
<i>Shigella</i> species	Dysentery	"
<i>Streptococcus pyogenes</i> (Lancefield's group A haemolytic streptococci)	Scarlet fever, sore throat, puerperal sepsis, etc.	"
<i>Staphylococcus aureus</i>	Food-poisoning, sepsis, etc.	Bacteriophage
<i>Streptococcus pneumoniae</i> (pneumococcus)	Lobar pneumonia	Serology
<i>Corynebacterium diphtheriae</i>	Diphtheria	Morphology in culture, serology, and physiology
Influenza virus	Epidemic influenza	Serology

degree of certainty that can be put on this conclusion depends on the frequency with which the various types occur in the population.

Of the microbes that cause epidemics, those for which type identification is possible are listed in Table I, but a warning may be added here. The techniques of type identification are commonly difficult and the materials needed are usually available in only a few specialized laboratories. This means that there may be a few days' delay before the results of the tests can be given to the practitioner or medical officer of health. It also means that requests for type identification ought to be restricted to investigations where enough material has been collected to make the results useful.

Search for Source of Infection

The diagnosis and the history should indicate what sort of outbreak is occurring, and what investigations are needed to trace its source, to prevent further cases in the immediate future, and to prevent the occurrence of further outbreaks.

In outbreaks apparently due to infection of a common foodstuff an attempt is first made to demonstrate bacterial contamination of the food remnants, and then a search is made for carriers among the persons who had handled the food. In outbreaks consisting in dropping cases of bacterial infection a search may be made for chronic carriers among contacts and perhaps also for intermittent contamination of food. When there is evidence that a disease is spreading from case to case through a community we are concerned to discover those remaining susceptible to infection and also the potential dispersers of infection; in some examples of this type it may be possible to control the outbreak by isolating all infected persons, but often specific protection of the remaining susceptible persons may offer more hope of success.

Laboratory assistance in the investigation of the source of outbreaks is thus most often required in a search for healthy carriers and for other animate or inanimate sources of the causal organism.

Truly chronic healthy carriers are particularly important in the propagation of typhoid fever, and they also play a part in the spread of streptococcal and staphylococcal infections. In food-poisoning due to salmonellae, and in dysentery, chronic carriers are unimportant, but patients recovering from the disease may continue to excrete the organisms and infect others.

In attempting to pin responsibility for an epidemic on a carrier discovered during investigations made after cases have occurred, it may be difficult to be certain that the carrier was not really a victim rather than the cause of the outbreak, but in either case he may still be a cause of further spread if opportunities occur.

In surveys for possible dangerous carriers it is most important, though often difficult, to examine everyone who may have been concerned. The kitchen staff may include a number of part-time members who are often understandably reluctant to submit to examination; repeated inquiry may be needed to establish the full complement.

The specimens to be obtained from suspected carriers in investigations of some of the more important infections are given in Table II. In the enteric fevers especially, the carrier state may sometimes be recognized by finding a

raised serum antibody titre (Widal reaction, typhoid Vi antibody titration), but the interpretation of these tests is often confused by antibodies resulting from earlier prophylactic inoculations. A raised titre of typhoid Vi antibody, however, is found only in persons who are still carrying the living organisms.

A raised antibody titre to the streptococcal toxin, streptolysin O, would similarly indicate recent infection with haemolytic streptococci, but this test is not widely used in a search for streptococcal carriers, partly because elevation of the titre is not invariable even with severe streptococcal infections, and partly because streptococcal infections are so common that only a method giving retrospective type-specific diagnosis would be useful. No such test has yet reached the stage of practical application. Other diseases in which antibody titration may be helpful include influenza, psittacosis, Q fever, undulant fever, and Weil's disease.

Relative Dangers of Carriers

With the intestinal infections, all carriers are commonly regarded as potentially dangerous. On the other hand, healthy persons who yield only small numbers of haemolytic streptococci, even of the pathogenic group A, are of little danger to their fellows, and there is good evidence that heavy nasal carriers are the persons particularly apt to spread the infection.

The hope animating any search for carriers among the contacts of the patients in an outbreak is that we may find a single person infected with the microbe causing the outbreak, and that he or she had the opportunity to spread the disease. Sometimes this hope is realized, and removal or neutralization of the carrier may, provided all the victims are accounted for and prevented from further dispersal, end the epidemic. Often, however, several carriers are found; one of these may perhaps be the source and the others victims—a distinction that may sometimes be possible from the history of the outbreak.

The presence of numerous carriers may also indicate that the microbe has already spread widely through the population, and may indeed have already infected many or all of those susceptible. In some circumstances this may indicate that the epidemic is burning itself out; in others, such as a hospital ward, it may show that the only ways of preventing further infection are by specific protection of the remaining susceptible patients or by closing the pathways along which infection is transmitted, including the isolation of infected persons.

Specific protection may be by the use of general chemoprophylaxis or, in diphtheria and smallpox particularly, by immunization. With diphtheria, indeed, it is also possible to distinguish the susceptible persons from the immune persons by means of the Schick test.

Animal Reservoirs

In considering the source of some epidemics, animals have to be considered. The *Salmonella* organisms responsible for food-poisoning may be pathogens or harmless commensals of domestic animals—the risk from infected duck eggs is so well known now that an infected patient who has had a duck egg within the past few days is often hardly questioned further. Epidemics of psittacosis arise from contact with sick birds, not only parrots; epidemics of bovine tuberculosis and Q fever start with infection derived from cattle or, in the latter case, other animals; and infection in Weil's disease is derived from rats.

Method of Spread of Infection

Inseparable from the investigation of the source of the epidemic—using "source" for the person or animal in whom the microbe was previously living—is the investigation of the way in which the organism was spread. We can distinguish spread by food and drink, by direct or indirect contact, by the air, and by insect vectors. With the possible exception of flies, spread by insects is so rare in this country

TABLE II.—Specimens Required from Suspected Carriers

Disease	Specimens
Enteric fever	Faeces and urine. Serum for detection of raised antibody titre in chronic carriers or convalescents
Salmonella food-poisoning	Faeces
Dysentery	
Staphylococcal infections and food-poisoning	Swabs from nose and throat, from skin of hands, and from any active or healing septic lesion
Streptococcal infections ..	Swabs from nose and throat and any septic lesion
Diphtheria	Swabs from nose and throat (or wound)

that it is not considered here. The distinction between these methods usually has to be made from the history of the outbreak and from comparison of attack rates on different groups of people who had various degrees of association with one another, or were exposed to various possible sources of infection.

Food-borne outbreaks are commonly, though not always, abrupt in onset; accurate history-taking often leads to a clear indication of the source of the infection. The enteric diseases and food-poisoning are always spread by infected or toxic food, and in the investigation of such outbreaks collection of samples of foodstuffs is important; these should be sent to the laboratory immediately, because, if kept, the pathogenic organisms may be overgrown by saprophytes. With diseases like typhoid fever, however, which have an incubation period of 10 days, it is quite likely that contamination of food or water with the typhoid bacillus has ceased by the time that investigations are begun. Some help may still be given by laboratory investigations, which may reveal, for example, faecal contamination of water supplies, faulty food-handling habits, or inadequate heat treatment of milk or ice-cream, and so indicate methods for the prevention of further outbreaks.

In both "dropping-case" and "spreading" outbreaks in hospitals hopes of prevention lie in investigation and the closing of the routes of infection, especially by improvements in the aseptic routine. For this it is often necessary to spend a great deal of time in the affected department, quietly observing the routine as it is followed; it will often be found to differ from that prescribed by authority.

In investigating outbreaks in hospitals and schools it is often possible to obtain evidence of widespread dissemination of the epidemic microbe on bed-clothes, in floor dust, on surfaces, and in the air; and bacteriological investigations of fomites may suggest the route of transmission. It is well to remember, however, that the finding of, for instance, large numbers of streptococci in the floor dust of a school suffering an epidemic of scarlet fever does not necessarily imply that the victims were infected by dust-borne streptococci; it may be that the streptococci in the dust are no more than a by-product of dispersal from carrier to new host by much more direct means.

In one special case the method of transmission of infection may be discovered, but not the person from which the infection is derived. This is the syringe-transmission of infective hepatitis: the causative virus may be carried in the blood of apparently healthy persons and be transferred to others by inadequately sterilized hypodermic syringes or needles; the infecting dose of virus is so small that it may be contained in an almost imperceptible amount of blood.

Conclusion

Clearly, methods for the investigation of all epidemics cannot be prescribed in a short article; all that can be done is to indicate some of the broad lines of approach, and the part that the laboratory can play in the investigations. The medical officer of health, on the epidemiological side, and the laboratory, on the microbiological side, can give guidance to the practitioner on the specimens that should be examined and the investigations that may profitably be made in any particular outbreak. The part played by the Public Health Laboratory Service, which was constituted to give assistance in the investigation of epidemics, was described by Dr. M. T. Parker in a previous article in this series (October 10, 1953, p. 823).

The investigation of outbreaks of infection has often consisted solely in the analysis of numbers of cases and of attack rates on the various sex and age groups of a population that are readily accessible in the, often inadequate, written records. Analyses of attack rates are essential, but to show their real value they have to be done in the first few hours of the investigation, for their first purpose should be to guide the field and laboratory investigations. The source of any but the simplest of epidemics can rarely be found unless the investigations are started as soon as there is

reasonable suspicion of the existence of an epidemic, and it will certainly not be found without a concerted clinical and laboratory investigation on the spot. With information gained from such full investigations, retrospective analysis may be expected to indicate the way in which further outbreaks may be prevented.

Next article on Clinical Pathology.—"Examination of Faeces for Infection and Infestation," by Dr. K. B. Rogers.

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MEDICAL AND SOCIAL PROBLEMS OF THE AFRICAN IN INDUSTRY

BY

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The industrial and mining development of the greater part of the African continent is still in its infancy. Full development will result in its attaining a position of great economic and strategic importance in the world, but cannot be carried out without native African labour. The future prosperity of Africa rests upon this, unless some equally suitable type of labour can be found. No true thought or consideration has been given to this fact by those in whose hands the existing development of the continent up to the present has lain. This seems to have been due to ignorance of the economic and social hazards of a policy of *laissez faire*, combined with the fact that labour supply has exceeded demand and the sources have been primitive peoples with a high reproductive rate whose mental horizons and economic needs were until recently of the lowest possible order.

Social Conditions

To-day in a large part of the African continent the industrial and mining development which has taken place has created terrible social conditions associated with poverty, malnutrition, disease, and crime. The terrifying proportions of these social evils appal the mind when viewed in the nakedness of their true facts. The social burden of the corrective measures necessary to deal with the situation now in existence is likely to be extremely heavy if the measures required are to prove effective. Indications are that such measures are beyond the means of the community as at present constituted. The social unrest which must inevitably spring from the continued existence of these conditions is likely to lead to economic and political disaster.

Whether sufficient knowledge or foresight could have been expected from those responsible for the creation of the present conditions one cannot say. Nevertheless I am of the opinion that a repetition of the mistakes elsewhere can be avoided by a knowledge of those of the past. It is the intention of this paper to discuss the medical and social impact of certain procedures which have been adopted to obtain native industrial labour, and the ultimate effect which they are likely to have if imposed upon primitive native peoples. It is based upon five years of general practice in an area where some of the conditions described exist. If it prevents similar conditions arising during the future development of the relatively untouched African territories then its purpose will have been well served.