Outbreak investigation

Modern epidemiology originated with the study of epidemics of infectious disease in the late 19th century. The study of disease outbreaks and epidemics is still an extremely important and challenging task for public health epidemiologists in the 21st century.

Outbreaks and epidemics

An epidemic is defined as 'the occurrence in a community or region of cases of an illness clearly in excess of normal expectancy' (Last 1995).

The presence of an epidemic is relative to the number of cases that we would expect to occur in a specific population and time period. For example occurrence of few cases of typhoid may be considered an epidemic in one population while the same situation may be normal occurrence in another population.

If the increase in the incidence of a disease is localized to an institution, town or village, the term 'outbreak' is often used. But if an epidemic occurs over a wide geographical area, across several countries it is often called a 'pandemic' for example the pandemic of avian flu in humans in 2004 and the pandemic of AIDS since 90s of the last century.

Types of outbreak

1. Common source outbreak: when all infections happen from the same source e.g. food, water. Common source epidemic is further divided to:

    a. Point source: when all infections happen from a single exposure e.g. when 50 people eat a meat broth in a party and 10 of them get diarrhea next morning. The epidemic curve will be sharp and bell shaped like the figure above.

    b. Extended source outbreak: when there is repeated exposure to the same source of infection such as contaminated water well. The epidemic curve will be broad.

2. Propagated outbreak: an epidemic in which the infectious agent continues to spread from persons to person. In this case the infection will last for a longer time and there will be several peaks in the number of the cases. Measles and chickenpox can start as a common source epidemic in a school and continue as a propagated epidemic.

Objectives of outbreak investigation

Outbreak investigation is a public health decision which mainly depends on the severity and transmission potential of the disease. If a disease has major consequences in terms of mortality or morbidity or if a disease has a high potential for transmission, even if not high in fatality, it will be necessary to investigate the outbreak. Most countries require the mandatory investigation of outbreaks of certain specified diseases. The WHO requires the investigation and reporting of outbreaks of cholera, plague and yellow fever. We may decide to investigate an outbreak for one or more of the following purpose:

- Control: Outbreak investigation aims to provide information on the cause and source of infection which could be used to control the outbreak
- Prevention: Even if an outbreak is over or dying out, it may still be useful to investigate it in order to help prevent occurrence of further outbreaks in the future.
- Research: Outbreak investigation is an opportunity for researchers to test and improve their research skills and gain more information on the infectious agents and their modes of transmission
- Programme evaluation: Outbreak investigation can identify gaps and limitations in programmes underway to control infectious diseases.
- Epidemiological training: Outbreak investigation provides an opportunity to public health workers and junior professionals to learn field investigations

Steps in undertaking and outbreak investigation

Although an outbreak is usually an urgent issue and requires rapid response from the health authorities to identify and control source of infection, yet it is essential to follow a systematic method to investigate the outbreak. The pressure and the urgency to respond should not be an excuse for a faulty outbreak investigation.

Step 1: Collect background information

Once the presence of the outbreak is suspected, we must familiarize ourselves with the disease. An outbreak may be suspected by public health professionals, clinicians, analysis of surveillance data, or even by the public. In an outbreak, the disease is usually already known but sometimes, the diagnosis is not yet clear and even it could be a new unknown disease. In any case we must search the literature and gather information on the following aspects of the disease:

- The infectious agent
- Clinical presentation
- Diagnostic tests
- Incubation period and infectious period.
- Mode of transmission routes
- Measures for prevention and control
- Previous outbreaks of the disease

Step 2: Establish the true existence of an outbreak

The outbreak is usually suspected at first and we have to make sure that there is a real outbreak. For this we have to firstly verify the diagnosis of the reported cases and secondly compare the observed number of cases with the expected number in the same population and time period. If number of cases is clearly in excess of what we would expect after considering alternative explanations, we would be able to verify occurrence of an outbreak.

To verify the diagnosis of all reported cases we need to develop a preliminary case definition and use it to verify the diagnosis of reported cases. A preliminary case definition will usually specify the clinical features, time period and geographical limits that establish the boundaries of a case. The case definition should be sensitive enough to identify most of the actual cases and specific enough to avoid too many false positives. We may use more than one case definition and we can modify our case definitions when we gather more information during the investigation.

Comparing the observed number of cases with the expected number is essential to establish the existence of an outbreak. The observed number should be clearly in excess of what is expected. The number of expected cases could be obtained from surveillance data and reported cases of previous periods. If data about previous periods was not available, we have to decide whether we would go ahead with the outbreak investigation or not depending on the particular situation and disease considerations.

There could be alternative explanations for increase in the number of cases. For example we have to exclude any changes in the case definition and reporting system which could be responsible for the increased number of cases. We have also to be aware than the increase of cases may be due to increase in the population.

Step 3: Identify additional cases

The reported cases are not usually all the cases of the disease that have happened in the population. Therefore we have to search actively for additional cases that could exist. We may do this through contacting and talking to reported cases, health facilities and laboratories.

Step 4: Collect preliminary data

Now as we have identified reported and additional cases. We start to collect preliminary epidemiological data about the time, place and person characteristics of the cases. We identify relevant variables and design appropriate data collection tools covering demographic, clinical, lab and other relevant aspects of the disease.

Step 5: Describe the outbreak in terms of time, place and person

With the data we have collected we should be able to describe the outbreak in terms of time, place and person. We can draw an epidemic curve and identify type of the epidemic. If we know the incubation period of the disease we can establish the probable time of exposure. If the epidemic curve is that of point source epidemic, we can calculate the minimum, maximum and average incubation periods.

We can report on the geographic distribution of cases by plotting the location of cases on a map. We may plot the cases according to location of sources of water, food, and other relevant localities. The cases could also be tabulated according to personal characteristics such as age, sex, occupation, travel, and other variables relevant to the disease occurrence.

Step 6: Formulate provisional hypothesis

At this stage when we have done detailed analysis of the data, we would have some ideas about the causes and sources of the outbreak. We should not jump to final conclusions about the etiology and source of the outbreak. Instead, we should use this information to formulate a hypothesis about the cause of the outbreak. The information we have collected may lead us to more than one hypotheses about the disease.

Step 7: Test the hypothesis

Unless we are pretty sure that the available evidence we have collected from the outbreak investigation points clearly to one hypothesis about the cause of the

outbreak, we need to test our hypothesis. Often we need to undertake an analytical epidemiological study such as a case-control study or a retrospective cohort study, to test our hypothesis. In addition to analytic studies, we may need to do lab tests, other diagnostic tests and environmental tests on the cases and suspected sources to identify the causative agent.

Step 8: Provide recommendations for control and prevention

Based on the results of our investigation and further analytical studies, we have to formulate clear recommendations about the outbreak to help the clinicians, health authorities and other relevant partners to manage cases and undertake interventions to control the current outbreak and prevent reoccurrence of the infection in the future.

Step 9: Communicate the findings

Since outbreaks are of public concern and their control needs joint action by different partners, the public and individuals, it is important to communicate findings of the investigation widely to the health authorities, the local and wider community, the clinicians, and other relevant authorities.