# 1 Basic concepts and applications of epidemiology

## Overview

Epidemiology is a basic science of public health. Its principles and methods are used to: describe the health of populations; detect causes of health problems; quantify the association between ill health and determinants; test treatments and public health interventions; and monitor changes in states of health over time. The key feature of epidemiology is that it is a study of populations, not individuals. In this chapter you will learn the basic concepts and applications of this discipline.

## Learning objectives

**After working through this chapter, you will be better able to:**

- **describe the key aspects of the epidemiological approach**
- **discuss the models of causation of disease**
- **describe the natural history of disease**
- **discuss the applications of epidemiology in public health practice.**

## Studying epidemiology

Epidemiology is the study of the distribution and determinants of health states or events in specified populations, and the application of this study to control health problems. It is concerned with the collective health of people in a community or an area and it provides data for directing public health action. Given the definition above, it follows that knowledge of the distribution and determinants of health states and events informs appropriate public health action.

### What is the distribution of health states or events?

The *distribution* of health states or events is a description of the frequency and pattern of health events in a population. The *frequency* (e.g. the number of occurrences of a health event in a population within a given time period) is measured by rates and risks of health events in a population, and the *pattern* refers to the occurrence of health-related events by time, place and personal characteristics. (Rates and risks will be discussed more in Chapters 2 and 3).

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### What are determinants of health states or events?

Epidemiology seeks to identify the determinants of health and determinants of disease. The determinants of health states or events are definable factors that influence the occurrence of health-related events. Determinants are also known as risk factors or protective factors, depending on which health-related events they are associated with. Health-related events refer to health outcomes (e.g. death, illness and disability) as well as positive health states (e.g. survival and reduced risk of stroke), and the means to improve health.

## The epidemiological approach

Like detectives, epidemiologists investigate health-related events in a rigorous way. An epidemiologist's approach to studying these events involves answering the questions:

- what?
- who?
- where?
- when?
- why?

These questions can be referred to as:

- case definition
- person
- place
- time
- causes

### What?

A *case definition* is a set of standard criteria for deciding whether or not a person has a particular disease or health-related event. A case definition consists of clinical criteria, sometimes with limitations on time, place and person. The clinical criteria usually include confirmatory laboratory tests, if available, or a combination of symptoms (complaints) and signs (physical findings), and other supportive evidence. For example, in the USA, the case definition for paralytic poliomyelitis used by the Centers for Disease Control and Prevention (CDC 1992: 461) is: 'Acute onset of a flaccid paralysis of one or more limbs with decreased or absent tendon reflexes in the affected limbs, without other apparent cause, and without sensory or cognitive loss'. Application of standard criteria ensures that every case is diagnosed in the same way regardless of when and where it occurred. This allows comparison of rates of occurrence of the disease between populations and over time.

A case definition may have several sets of criteria, depending on how certain the diagnosis is. For example, during an outbreak of measles, you may classify a person with fever and rash as a suspected case of measles; one with fever, rash and a history of contact with a confirmed case of measles as a probable case of measles, and one with fever, rash and a positive serologic test for measles IgM antibody as a confirmed case of measles.

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A case definition may also include *exclusion criteria* to exclude people even if they meet the criteria for a case. For example, cases may be excluded on the basis of their age.

### Who?

Counting the number of *persons* involved in a health event is one of the basic first steps in an epidemiological investigation. However, a simple count of cases is inadequate for comparing the occurrence of disease in different populations or during different times, so case counts are converted into risks or rates, which relate the number of cases to the size of the population (you will learn more about risks and rates in Chapter 2).

People differ in certain inherent characteristics (e.g. age, ethnic group, sex), acquired characteristics (e.g. immunity, nutrition), socioeconomic conditions (e.g. education, occupation, housing), or health-related beliefs and behaviours (e.g. tobacco or alcohol consumption, health care seeking). Since personal attributes are often associated with health events, differences in the distribution of these factors should also be considered while comparing occurrence of health events between populations.

### Where?

Health events are described by *place* to gain insight into the geographical difference or extent of the event. The place can be, for example, place of residence, birth or employment, a district, a state, or a country, depending on what is appropriate to the occurrence of the health event. Analysis of data by place can also give clues as to the source of agents that cause disease and their mode of transmission. A spot map is a map on which each case is related to a specific type of place, such as a place of work; such maps can be useful in identifying the source of the causal agent while investigating an outbreak.

### When?

Rates of occurrence of disease often change over *time*. Plotting the annual rate of a disease over a period of years can show the long term or secular trends in the occurrence of the disease. These trends can be used to help predict the future incidence of a disease and also to evaluate programmes or policy decisions, or to suggest what caused an increase or decrease in the occurrence of a disease. Figure 1.1 is an example of such a graph.

### Activity 1.1

Figure 1.1 shows a declining trend in the incidence of rheumatic fever in Denmark since 1900. The incidence drops particularly sharply after 1900, having been quite steady for the previous 40 years. What might this suggest?

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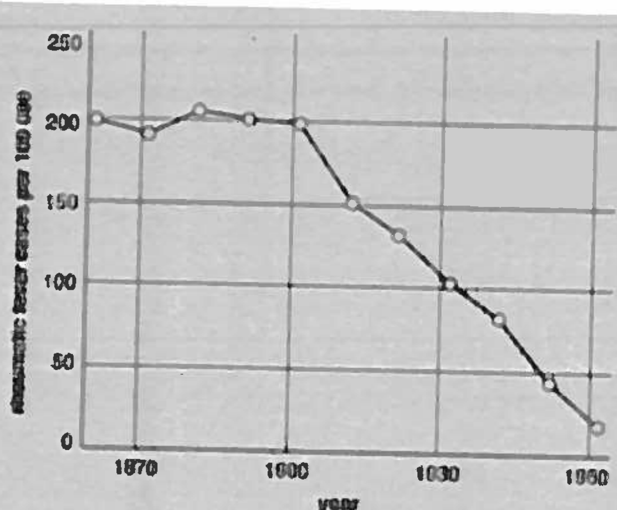


**Figure 1.1** Incidence of rheumatic fever in Denmark, 1862–1962
Source: from Beaglehole et al. (1993)

**Feedback**

The nature of the curve suggests that some event or action might well have triggered the decline in the incidence of rheumatic fever around 1900.

Rheumatic fever is caused by haemolytic streptococcal infection, which is associated with poverty and overcrowding. It is, therefore, plausible to attribute the decline in rheumatic fever to the improvement in socioeconomic conditions in Denmark that occurred at the beginning of the twentieth century.

Graphs of the occurrence of a disease by week or month, over the course of a year or more, show its seasonal pattern. Some diseases are known to have typical seasonal patterns; for example, the incidence of influenza increases in winter.

### Why?

In addition to describing the levels and patterns in the occurrence of health events by person, place and time, epidemiology is concerned with the search for causes and effects. Epidemiologists quantify the association between potential determinants of health states and health events, and test hypotheses about causality and associations between the determinants and health events. There are several epidemiological study designs, but their shared basic principle is to make an unbiased comparison between a group with and a group without the determinant or health event under investigation (study designs are dealt with in detail in Chapters 4–8).

## Models of causation of disease

In order to understand the principles and applications of epidemiology, you need to know the potential processes and pathways by which various factors can lead to ill health. There are several models of causation that have been proposed to help the understanding of disease processes. In epidemiology, the models widely applied are:

- the epidemiological triad
- the sufficient cause and component causes model

### The epidemiological triad

The epidemiological triad or triangle is the traditional model of causation of infectious diseases (Figure 1.2). It is based on three components: an external *agent*, a susceptible *host*, and an *environment* that facilitates interaction between the host and the agent. The agent might be a microorganism such as a virus, bacterium or parasite; or a chemical substance. Host factors are the intrinsic factors that influence an individual's exposure, susceptibility, or response to a causative agent: for example, age, sex, ethnic group, and behaviour are some of the factors that determine an individual's risk of exposure to an agent; age, genetic composition, nutritional and immunological status are some of the factors that influence individual susceptibility and response to an agent. The environmental factors are extrinsic factors that affect the agent and the opportunity for exposure. They include physical factors (e.g. climate, geological characteristics), biological factors (e.g. vectors – insects that transmit an agent) and structural factors (e.g. crowding, and availability of health and sanitation services).

Agent, host and environmental factors are interrelated in many ways. The balance and interactions between them that lead to the occurrence of disease in humans vary for different diseases.

This model can work for some non-infectious diseases, but there can be difficulties because certain factors are not easily classified as agents or environmental factors.

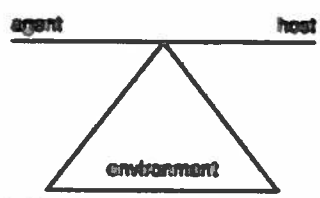


**Figure 1.2** The epidemiological triad

### Sufficient cause and component causes model

A *sufficient cause* is a set of factors or conditions that inevitably produces disease. The factors or conditions that form a sufficient cause are called *component causes*. Component causes include host factors, agents and environmental factors. If a disease does not develop without the presence of a particular component cause, then that component cause is classified as a necessary cause. However, a single component cause, even if it is a necessary cause, is rarely a sufficient cause by itself.

For example, exposure to the infectious agent *Mycobacterium tuberculosis* is a necessary cause for tuberculosis, but it is not sufficient as it does not always result in disease (some people may not develop the disease or may become carriers). Whether a person develops a disease or not depends on other component factors which determine their susceptibility, such as their immune status, concurrent conditions (e.g. HIV infection, diabetes, silicosis), genetic factors, age and socio-economic status. Similarly, smoking is a component cause for lung cancer (smoking increases the risk of lung cancer). However, smoking is not a sufficient cause because not all people who smoke develop lung cancer; nor is it a necessary cause because lung cancer can develop in non-smokers.

## Activity 1.2

Three sufficient causes (1, 2 and 3) and their component causes (denoted by letters) of a hypothetical disease are shown in Figure 1.3. If there are no other sufficient causes of this disease, which component cause is a necessary cause?

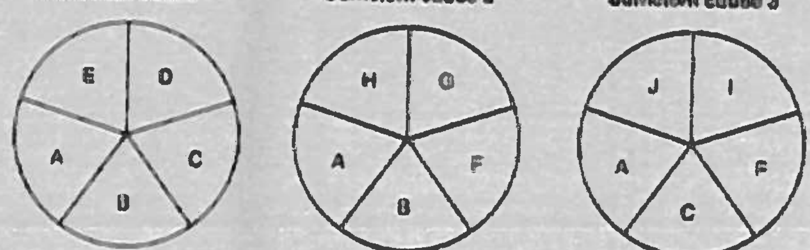


**Figure 1.3** Conceptual scheme of three sufficient causes of a hypothetical disease
Source: based on Rothman (2002)

## Feedback

Component cause A is the necessary cause since this factor is part of all three sufficient causes; it must be present in combination with other factors for this disease to occur.

If Figure 1.3 were a representation of the only sufficient causes of tuberculosis, then *Mycobacterium tuberculosis* would be represented by component cause A, the necessary cause. Other factors such as immunity, concurrent illness, genetic and socioeconomic factors would be represented by components B, C, D, E, F, G, H, I and J.

On the other hand, if Figure 1.3 were a representation of some of the sufficient causes of lung cancer, then smoking could be represented by B which is present in sufficient causes 1 and 2, but not in 3. Sufficient cause 3 may be the cause of lung cancer in individuals who do not smoke.

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This conceptual scheme is able to show that a disease can occur from different sufficient causes, and that component causes may be unknown (as is often the case in non-communicable diseases). The scheme also demonstrates that it is not necessary to identify every component of a sufficient cause in order to prevent a disease; a disease can be prevented by eliminating *any single component cause* since this prevents completion of a sufficient cause. For example, eliminating smoking (component B) would prevent lung cancer from sufficient causes 1 and 2, although some lung cancer would still occur from sufficient cause 3.

## Natural history of disease

The *natural history of disease* refers to the progress of the disease process in an individual over time and in the absence of intervention (Figure 1.4). Knowledge of the natural history of a disease helps us to understand the effects and mechanism of actions, potential interventions, and the different levels of the prevention of disease.

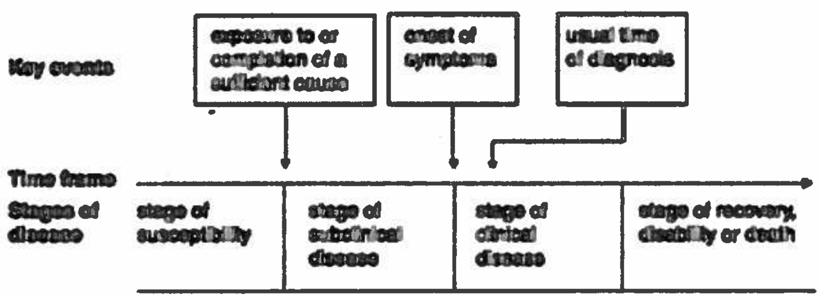


**Figure 1.4** Natural history of disease

*Source*: based on CDC (1992)

The *disease process* begins with exposure to, or completion of, a sufficient cause of the disease. Without an appropriate intervention, the process ends with recovery, disability or death. For example, exposure to the measles virus in a susceptible individual initiates the stage of subclinical disease. The onset of fever on about the 10th day (range 7–18 days) after exposure marks the beginning of clinical disease. The disease, however, is usually diagnosed around the 14th day when the typical rashes appear and then the disease proceeds to recovery, to complications such as pneumonia, or to death, depending on host and other factors.

Many diseases have a typical natural history, but the time frame and manifestations of disease may vary between individuals due to the presence of host factors (e.g. immunity and age) and other determinants of the disease. Many factors may affect the progress of a disease in an individual and the likely outcome. The estimation of an individual's outcome, taking into account the natural history of disease and other risk factors, is known as their *prognosis*.

The course of a disease may also be modified at any point in the progression by preventive and therapeutic measures. The subclinical stage following exposure is usually called the *incubation period* (for infectious diseases) or the *latency period* (for chronic diseases).

## Applications of epidemiology in public health

Epidemiological principles, methods, tools and information are applied in every aspect of public health from policy setting at a macro level to decision making at individual level. The brief discussions that follow, although not exhaustive, will give you an idea of the spectrum of application of epidemiology in public health.

### Community health assessment and priority setting

In order to set priorities and appropriate policies, and be able to plan programmes, public heath professionals need answers to questions like the following:

- What are the actual and potential health problems in the community?
- Where and among whom are they occurring or would they occur?
- Which problems are increasing or decreasing, or have the potential to increase or decrease over time?
- How do the levels and patterns of health problems relate to the existing health services?

Epidemiological methods and tools provide answers to these and other related questions and help decision making for health policies and programmes.

### Evaluating health interventions and programmes

Epidemiological studies of the *efficacy* (how well a health intervention works under ideal conditions) and *effectiveness* (how well a health intervention works under usual conditions) of health interventions provide important information for identifying appropriate interventions. Ongoing surveillance of diseases is essential to ensure the continued safety and effectiveness of health interventions. Epidemiological principles and methods are also used in evaluating health policies and programmes.

### Preventing disease and promoting health

Epidemiological studies contribute to the understanding of the causes, modes of transmission, natural histories and control measures of diseases. This understanding is essential for developing appropriate health promotion strategies to prevent disease perhaps in those most at risk, or as a population-wide effort by tackling known causes. Studies can provide information on the effectiveness of health promotion interventions and identify for whom they are most effective to help direct resources.

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### Improving diagnosis, treatment and prognosis of clinical disease

Epidemiological research contributes to identification of appropriate tests and criteria for diagnosis and screening. It is important to know the diagnostic accuracy of tests, that is, how well a test can discriminate between those with and without the disease (you will learn more about diagnostic accuracy and screening in Chapter 11). Epidemiological research can help determine the most effective treatment in a given situation and the likely outcome of patients, which is essential for planning care.

### Activity 1.3

You have been given a lot of material to take in; some of it is intuitive, some less so. In order to help you put these ideas in context, you will now look at a famous example from the nineteenth century.

John Snow (1813–58) was a distinguished physician. As an epidemiologist, he is best known for his studies of cholera, in particular of two outbreaks that occurred in London in 1848–9 and 1854. This exercise is based on his work and illustrates the epidemiological approach from descriptive epidemiology to hypothesis generation and testing, and the application of epidemiological data.

Activities 1.3–1.7 are interrelated and use John Snow's cholera studies as an example. Feedback follows each activity so that you are prepared for the next one, but don't read the feedback until you have tried to answer the question for yourself. The answers given in the feedback are not the only 'correct' answers. There are many ways to approach these questions, and your answers can be different from those given in the feedback.

Cholera periodically swept across Europe during the nineteenth century. After a severe epidemic in 1832, the disease next appeared in London in 1848. The first definite case of the outbreak occurred in September 1848 and was that of John Harnold, a seaman of the ship Elbe, newly arrived from Hamburg where cholera was prevalent. Mr Harnold died a few hours after the onset of symptoms on 22 September in a lodge near the River Thames. The next case occurred in the same room; Mr Blenkinsopp, who lodged in the room, had cholera on 30 September. During the epidemic approximately 15,000 deaths were recorded. The mortality from cholera in this epidemic was particularly high in residential areas downstream, but decreased progressively upstream. Since water must flow downhill, upstream areas are, of course, at lower risk than those further downstream.

Snow had previously documented several circumstances in which people who had come into contact with cases of cholera developed the disease within a few days. While investigating several case series of cholera, he had made the following observations:

- Cholera was more readily transmitted in poor households and to those who had handled a case of cholera.
- The mining population had suffered more than people in any other occupation.
- Almost no physician who attended to cholera cases or did post-mortems had developed cholera.

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- Most cases of cholera developed within 24–48 hours after contact with a case of cholera.
- The disease was characterized by profuse painless diarrhoea and often proceeded with so little feeling of general illness that the patient did not consider himself in danger, or seek advice, until the malady was far advanced.

Based on these observations, Snow postulated the following hypotheses on the mode of transmission of cholera:

- Cholera can be transmitted from the sick to the healthy.
- Cholera is caused by some material (Snow called it 'morbid matter') which has the property of increasing and multiplying in the body of the person it attacks.
- The 'morbid matter' producing cholera must be introduced into the alimentary canal by swallowing.
- The 'morbid matter' may be transmitted through water from the sick to the healthy.

Microorganisms had not yet been discovered and one of the popular beliefs about the causation of disease was the theory of 'miasma' – that breathing 'bad air' caused disease.

1 How do you think Snow interpreted his observations to test his hypotheses and to refute the miasma theory?

2 What are the plausible explanations for the observed association between the elevation of the residential area and the level of mortality from cholera?

## Feedback

1 Snow argued that the risk of transmission of cholera was high in miners and other people of lower socioeconomic status because these groups had poor hygiene practices and were, therefore, more likely to have contact with faecal matter from cholera patients (especially through wet linen) than those of higher socioeconomic status. On the other hand, not many physicians developed the disease because they washed their hands after seeing each cholera patient. If the transmission were through air or a vector, the disease would have been transmitted from cholera patients to more physicians. Thus, the disease must be caused by some form of 'morbid matter' that is transmitted by direct contact.

Citing the observation that there were very few or no signs of general illness at the beginning of the disease, Snow proposed that the 'morbid matter' must be multiplying in the alimentary canal rather than in the blood. If the 'morbid matter' were transmitted by direct contact because of poor hygiene practices, and if the 'morbid matter' multiplied in the gut, then swallowing the 'morbid matter' would produce the disease.

2 The observed association between the elevation of area of residence and mortality from cholera could support the theory of bad air causing cholera. However, Snow argued that the water downstream was more likely to be polluted with sewage than the water upstream. Thus, the increased risk of transmission of cholera in the areas downstream supported his theory that the 'morbid matter' was most probably transmitted through water.

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## Activity 1.4

During the nineteenth century, drinking water in London was supplied by private companies, which obtained water directly from the Thames. Each company had its own network of pipes and in some areas these networks overlapped to such an extent that the houses along a single street might be supplied by more than one company. The Southwark and Vauxhall (S & V) Company and the Lambeth Company were the two major companies that supplied water to cholera epidemic areas during these periods.

London was free of cholera from 1849 until 1853, and during this period the Lambeth Company moved its source of water upstream to an area outside London, while the S & V Company continued to draw water from a downstream source within London. When cholera reappeared in London in July 1853, Snow visited households where a cholera death had been recorded and collected information on the routine sources of water. The water sources for the households of the first 334 deaths are shown in Table 1.1.

**Table 1.1** Water sources of households of people who died of cholera in London in 1853

| *Source of water* | *Number of deaths* |
|---|---|
| S & V Company | 286 |
| Lambeth Company | 14 |
| Direct from river | 26 |
| Pump wells | 4 |
| Unknown | 4 |
| Total | 334 |

Source: based on Snow (1936)

1 Do the data presented in this table support Snow's hypothesis that cholera is transmitted through water? Give reasons for your answer.

2 What further questions would you ask before reaching firm conclusions from these data?

## Feedback

1 Snow managed to collect information on the source of water for 330 of the 334 deaths (99%). This is a very high level of success in follow-up. Although people might have misreported the source of water, this would probably have been at random (the chance of misreporting would apply equally to all sources of water).

2 The data seem to suggest that cholera mortality was higher in households that were supplied by the S & V Company than in those supplied by the Lambeth Company. You might continue to argue that the increased mortality in the households supplied by the S & V Company was due to the company's water source being downstream and that therefore the data support Snow's hypothesis that cholera 'morbid matter' is

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transmitted by water. However, although tempting, it is not appropriate to interpret the figures in this way, without asking the following fundamental questions:

a) How many households were supplied by the S & V Company and how many by the Lambeth Company?
b) What was the size of the populations supplied by each of these companies?
c) Were the two populations comparable in their socioeconomic status?

For instance, the S & V Company might have supplied water to more people than the Lambeth Company and this might explain the higher mortality in the population supplied by the S & V Company. It is also possible that since the S & V Company was drawing water from downstream, the households supplied by the company would have been in downstream areas and would be likely to be poorer than the households upstream. Thus, although these data appear to support Snow's hypothesis, more information is needed to be convincing.

## Activity 1.5

Snow collected data on the number of houses supplied by the S & V Company and the Lambeth Company. When the cholera epidemic recurred in London in 1854, he again collected data on sources of water in the houses of those who died of cholera. The number of cholera deaths per 10,000 houses during the first seven weeks of the epidemic (8 July to 26 August) in houses using different water sources is shown in Table 1.2.

Do you think these data are adequate to conclude that cholera mortality is higher in houses supplied by the S & V Company than in houses supplied by the Lambeth Company? Discuss your answer.

**Table 1.2** Sources of water and cholera mortality in London, 9 July–26 August 1854

| *Source of water* | *Total number of households* | *Number of cholera deaths* | *Deaths per 10 000 houses* |
|---|---|---|---|
| S & V Company | 40 046 | 1 263 | 315 |
| Lambeth Company | 26 107 | 98 | 38 |
| Other | 256 423 | 1 422 | 55 |

Source: Snow (1936)

## Feedback

The risk of cholera death in houses supplied by the S & V Company was 315/10,000; in houses supplied by Lambeth Company it was 38/10,000; and in houses supplied by other sources it was 55/10,000. These data suggest that the risk of cholera death was 8–9 times as high (315/37) in houses supplied by the S & V Company as in houses supplied by the Lambeth Company. However, to reach this conclusion, it has to be assumed that the number of people per household, their socioeconomic status, and other potential factors associated with the risk of transmission of cholera are

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comparable between these two populations. This might not be the case; for instance, the S & V Company might have supplied water to multiple-occupancy buildings while Lambeth supplied individual houses. If this were the case, then the risk of cholera death per house between the two populations would not be comparable since the average number of people per house would differ between them.

### Activity 1.6

Snow investigated a severe outbreak of cholera in the Soho area of London near his house. He collected the house addresses of all 616 recorded cholera deaths between 19 August and 30 September 1854. From these data he produced a spot map showing the distribution of cholera deaths and the positions of the water pumps (Figure 1.5).

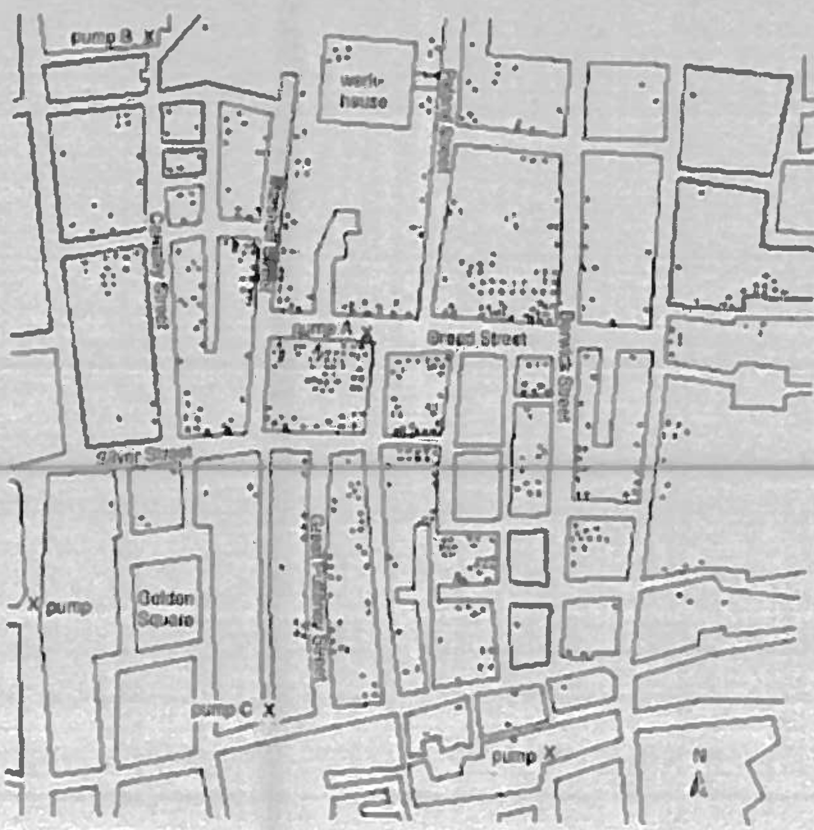


**Figure 1.5** Distribution of cholera cases around Golden Square, London, August–September 1854

Source: Snow (1936)

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1 Using Figure 1.5, describe the distribution of cholera deaths in relation to the position of water pumps.

2 What explanations can you think of for the differences in the distribution of deaths around water pumps A, B and C?

3 Can you conclude that water from pump A was the source of the cholera epidemic?

4 What further information do you need?

## Feedback

1 Figure 1.5 shows that there was spatial clustering of deaths around pump A and very few deaths near pumps B and C.

2 If water from the pumps was the source of cholera, why were there fewer deaths around pumps B and C than around pump A? It is possible that people did not drink the water from pumps B and C for reasons such as bad taste or smell; the pumps might not have been conveniently situated for use; the water from these pumps might not have carried the 'morbid matter' of cholera.

3 The explanations in answer 2 are not sufficient information on which to conclude that pump A was the source of cholera; there are two blocks of buildings very close to pump A where there was not a single death from cholera.

4 Although water from pump A might be the source, more information is needed to explain the absence of death in the two blocks nearby before reaching this conclusion. It would only be possible to implicate the water from pump A as the source of the epidemic if it could be shown that there was no death in these blocks for reasons such as:

a) no one lived there
b) the inhabitants had alternative sources of water
c) the inhabitants had some kind of protection against cholera.

## Activity 1.7

Snow discovered that a brewery was located in the two blockswith no deaths from cholera, and a deep well on the premises. The brewery workers and the people who lived close by collected water from the brewery well. In addition, the brewery workers had a daily quota of malt liquor. Snow was now convinced that pump A was the source of the cholera and he persuaded the local authorities to remove the pump. This was achieved on 8 September. The dates of onset of symptoms of the 616 fatal cases of cholera recorded between 19 August and 30 September are shown in Figure 1.6.

1 What does the graph in Figure 1.6 show?

2 Why do you think the epidemic stopped?

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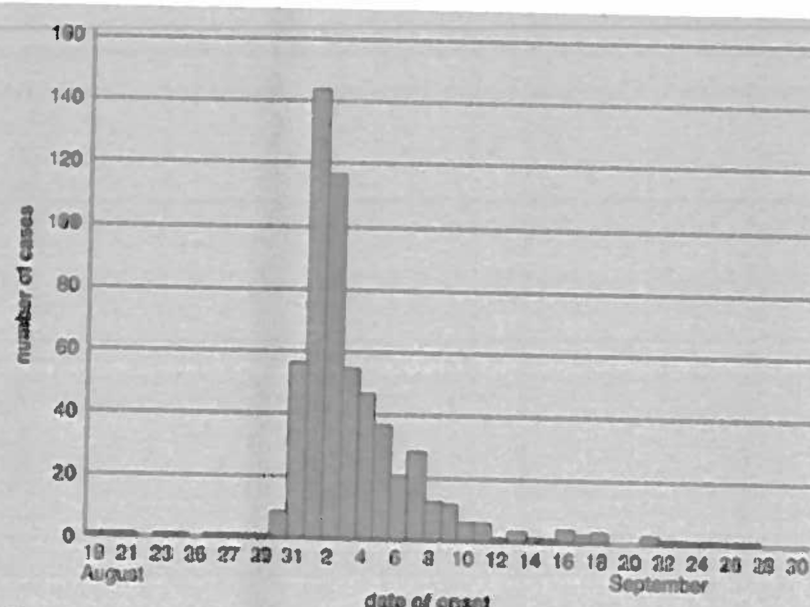


**Figure 1.6** Distribution of cases of cholera by date of onset

Source: based on data from Snow (1936)

**Feedback**

1 There appears to have been a low background incidence of cases (zero or one case per day) before 30 August. There was an explosive rise in the number of cases over 3 days, which decreased to previous levels after 12 days. The most likely explanation for the sudden rise in the incidence of fatal cases of cholera would be exposure of the population to a causal agent from a common source.

2 There are several possible explanations for the cessation of the epidemic:

a) People who lived in the area of epidemic might have moved out due to fear of contracting cholera.
b) If all susceptible people had been exposed within a short time, there would be very few susceptible individuals remaining.
c) The level of causal agent in the water could have been reduced.

It is unlikely that removal of pump A stopped the epidemic because the incidence of fatal cholera cases had already dropped almost to the background level by the time the pump was removed. However, another outbreak of cholera could have occurred if the number of susceptible individuals reached a critical point while the water from pump A contained the causal agent and was still available for use.

Bailey, Lucy; Chandramohan, Daniel; Langham, Julia. Introduction to Epidemiology.
Berkshire, GBR: McGraw-Hill Professional Publishing, 2005. p 17.
http://site.ebrary.com/lib/tourou/Doc?id=10161292&ppg=26

*Vibrio cholera*, the causal agent of cholera, was isolated by Robert Koch in 1883, several decades after Snow had concluded from his epidemiological investigations:

> I feel confident, however, that by attending the above mentioned precautions (personal hygiene, boiling soiled bedclothes of patients, isolation and quarantine, improved waste disposal, drainage, provision of clear water), which I consider to be based on correct knowledge of the cause of cholera, this disease may be rendered extremely rare, if indeed it may not be altogether banished from civilized countries.

## Summary

You should now be able to describe key aspects of the epidemiological approach to health events in terms of the event's distribution in person, place and time. You should be able to understand epidemiological models of causation of disease. You should be able to understand that results of epidemiological investigations are required to provide information about the natural history of disease and prognosis, and to help identify appropriate interventions and measures of control in public health.

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