# Chapter 4
# Outbreak Management

Peter Heeg and Ossama Rasslan

**Key points**

- Outbreaks of infection should be clearly defined, identified, and promptly investigated because of their importance in terms of morbidity, cost, improvement of patient care practice and institutional image.
- Proper steps and effective techniques should be used to investigate a suspected outbreak.
- Clear recommendations should be formulated to prevent further transmission and/or outbreaks.

## Introduction

Communicable disease outbreak investigation reflects what an epidemiologist does when investigating disease patterns. Analysis of patterns of disease occurrence leads to an understanding of their spread and control.[1] Outbreaks should be identified and investigated promptly because of their importance in terms of morbidity, cost, and institutional image.[2] Outbreak investigations may lead to sustained improvement in patient care.

Early identification of an outbreak is important to limit spread by health care workers or contaminated materials. A potential problem may be initially identified by nurses, physicians, microbiologists, or other healthcare workers, or through an infection surveillance program. Appropriate investigations are required to identify the source of the outbreak and to justify control measures.[3]

## Definitions

**Outbreak or epidemic:** An excess over the expected (usual) level of a disease within a geographic area; however, one case of an unusual disease (e.g., botulism) may constitute an epidemic.[3]

**Pandemic:** An epidemic that spreads in several countries, usually affecting many people.

**Endemic:** The usual level of a disease within a geographic area (e.g., a hospital); these 'sporadic' infections ("baseline incidence") represent most preventable healthcare-associated infections.

**Relative risk:** The relative risk (RR) is a measure of association between a disease or condition and a factor under study. It is calculated by dividing the incidence rate of those exposed to the factor by the incidence rate of those not exposed to the factor. If the RR = 1, the incidence in the exposed is the same as the incidence in the non-exposed; thus there is no association between exposure and disease. RR > 1 denotes a larger incidence in the exposed than in the non-exposed; thus exposure seems to increase the probability of developing the disease. RR < 1 denotes a smaller incidence in the exposed than in the non-exposed; thus exposure seems to decrease the probability of developing the disease.[1]

## Case definition

A case definition should be developed. It must include a unit of time and place and specific biological and/or clinical criteria. The inclusion and exclusion criteria for cases must be precisely identified. A graded definition (definite, probable or possible) often helps. The definition should differentiate between infection and colonization.[3]

**Example of case definition:** A definite case patient will be defined as a patient hospitalised in the geriatric ward in January, with diarrhoea, cramps, and vomiting and in whom routine culture of faeces identifies Salmonella species.

## Why Epidemics Occur

There are many reasons why an outbreak occurs. However, four common reasons are:

1. When susceptible individuals travel into an area where the infectious disease already exists and is endemic.
2. When humans or animals travel from an endemic area into a susceptible human population in whom the disease is not endemic, or when contamination of food, water or other vehicles takes place by an agent not normally present, such as anthrax spores placed into mail as a terrorist act.
3. When a preexisting infection occurs in an area of low endemicity and reaches susceptible persons as a result of new or unusual social, behavioral, sexual or cultural practices. Examples include migration of refugees during war time and pilgrimages to religious places.
4. When host susceptibility and response are modified by natural or drug-induced immunosuppression (e.g., cancer treatment, malnutrition or diseases such as acquired immunodeficiency syndrome).

In health care settings, outbreaks are typically related to hand or environmental contamination, invasive devices, and procedures.

## Types of Outbreaks

1. Community-acquired: e.g., possible foodborne outbreak, measles.
2. Healthcare-associated: when two or more cases of infection appear to be epidemiologically related.[4]

## Investigating an Outbreak

### A. Purpose and objectives of an outbreak investigation

The purpose of an epidemic or outbreak investigation is to identify ways to prevent further transmission or outbreaks of the disease.

The three main objectives are:

1. Identify the responsible etiologic agent,
2. Find the source of infection by studying the occurrence of the disease among persons, place or time, as well as determining specific attack rates,
3. Formulate recommendations to prevent further transmission.

### B. Outbreak Investigation Tasks

The Infection Control Committee takes the following steps to investigate a suspected outbreak of a communicable disease. These steps provide a guideline and may not proceed in sequence.

1. **Verify if an outbreak really exists.** Compare the number of current cases with the usual baseline incidence (from previous months or years). If local data are not available, compare to information found in national surveillance systems or the literature (however, these data may not be applicable to the local situation).

2. **Establish diagnosis of reported cases (identify agent).**
   Define cases based on the following common factors:
   - Population risk factors: e.g., age, race, sex, socioeconomic status.
   - Clinical data (e.g., onset of signs and symptoms, frequency and duration of clinical features associated with the outbreak, treatments, devices).
   - Laboratory results.

3. **Search for other cases that may have occurred retrospectively or concurrently.** Collect critical data and specimen information from:

- Laboratory reports
- Medical records
- Patient charts
- Physicians and nursing staff
- Public health data

4. **Characterize cases.**

a. Assemble and organize available information (in terms of time, place, and person) for analysis.

- **Time**
  - The exact period of the outbreak
  - The probable period of exposure
  - Date of onset of illness for cases; draw an epidemic curve.
  - Is the outbreak common source (single point source) or propagated (ongoing transmission)?
- **Place**
  - Service, ward, operating room.
  - Clustering of cases.
- **Person**
  - Patient characteristics (i.e., age, sex, underlying disease).
  - Possible exposures (i.e., surgery, nursing and medical staff, infected patients).
  - Therapeutic modalities (i.e., invasive procedures, medications, antibiotics).
  - From this information, the population at risk can be accurately described.

b. Calculate rates

- Incidence rate: The number of new cases occurring in the population during a specified period of time / number of persons exposed to the risk of developing the disease during that period of time.[1]
- Attack rate: The cumulative incidence rate of infection in a group over a period of an epidemic. The attack rate = Number of people at risk who are infected / Total number of people at risk.

The attack rate can also be stratified by relevant characteristics such as sex, age, location, or specific exposure (e.g., ventilation, catheterisation, operating rooms, and occupational exposure). [2]

5. **Formulate a hypothesis about the cause of the outbreak from epidemiological and clinical data.** Make a best guess to explain the observations. The hypothesis should explain the majority of cases.

6. **Test the hypothesis.** This may require a special study.

a. Many investigations do not reach this stage; investigation may end with descriptive epidemiology and then the problem goes away without intervention or does not require a special study. Whether or not an investigation is carried out, the hypothesis testing phase is a function of available personnel, severity of the problem, and resource allocation.

b. Examples of situations that should be studied:

- Infection associated with a commercial product.
- Infection associated with considerable morbidity (e.g., bacteraemia) and/or mortality.
- Infections associated with multiple services.
  For example: during an outbreak of food poisoning the rate of disease in young adults was 40% and in older individuals was 2%. It was 65% for those who ate in a popular cafeteria and only 3% for those who ate in other places. Therefore young children eating in the popular cafeteria are the ones who should be investigated regarding specific foods eaten.

c. Analyze data derived from case investigation. Determine sources of transmission and risk factors associated with disease.

d. Refine hypothesis and carry out additional studies if necessary.

7. **Institute control measures and follow up.** The aims are:

- To control the current outbreak by interrupting the chain of transmission.
- To prevent similar outbreaks.

The selection of control measures is determined by the results of the initial analysis in consultation with appropriate professionals

(i.e., infection control staff, epidemiologist, clinicians, microbiologists, nursing, and technicians). The control measures will vary depending on the agent and the mode of transmission.[3] (See Table 4.1)

**Table 4.1.** Immediate control measures for outbreak management

| Type of transmission suspected | Suggested action |
|---|---|
| Cross-transmission (transmission between individuals) | Patient isolation and barrier precautions determined by infectious agent(s) |
| Hand transmission | Improvements in hand hygiene (e.g., washing, disinfection, glove use) |
| Airborne agent | Patient isolation with appropriate ventilation |
| Waterborne agent | Check water supply and all liquid containers; use of disposable devices |
| Foodborne agent | Elimination of the food at risk |

8. **Evaluate efficacy of control measures.**

- Cases cease to occur or return to endemic level.
- No change occurs (if so, re-evaluate cases).
- Use the opportunity of an outbreak to review and correct other hospital practices which may contribute to an outbreak in the future.

9. **Communicate, and write a final report.**

During the investigation of an outbreak, timely, up-to-date information must be communicated to the hospital administration, and public health authorities. In some cases information may be provided to the public and the media with agreement of the outbreak team, administration and local authorities.

A final report on the outbreak investigation should be prepared describing the outbreak, interventions, and effectiveness, and summarize the contribution of each team member participating in the investigation. It should include recommendations to prevent any future occurrence. This report can be published in the medical literature and may be considered as a legal document.

## Determination of the source of infection in an outbreak

The source of infection may be:

1. Common source (single–point source): Same origin (i.e., the same person or vehicle is identified as the primary reservoir or means of transmission).

2. Propagated or continuing source (ongoing transmission): Infections are transmitted from person to person in such a way that cases identified cannot be attributed to agent(s) transmitted from a single source.

3. Both common and propagated source (intermittent source):
Intermittent exposure to a common source produces an epidemic curve with irregularly spaced peaks.

## Epidemic Curve

The character of an epidemic is determined by an epidemic curve. This is a graph in which cases are plotted according to the time of onset of illness.[3]

### Reasons for constructing an epidemic curve

To determine whether the source of infection was common, propagated, or both; the shape of the curve is determined by the epidemic pattern.
To identify the probable time of exposure of the cases to the source(s) of infection.
To identify the probable incubation period.
To determine if the problem is ongoing.

### Characteristics of an epidemic curve

1. An epidemic curve is a histogram.
2. Cases are plotted by date of onset of illness.
3. Time intervals (on the X axis) must be based on the incubation or latency period of the disease and the length of the period over which cases are distributed.[3]

**KEY**

**A** Propagated source: single exposure, no secondary cases (e.g., measles).

**B** Propagated source: secondary and tertiary cases (e.g., hepatitis A).

**C** Common source: point exposure (e.g., Salmonellosis following a company picnic) (food handler = x).

**D** Common source: Intermittent exposure (e.g., bacteraemia associated with contaminated blood product).

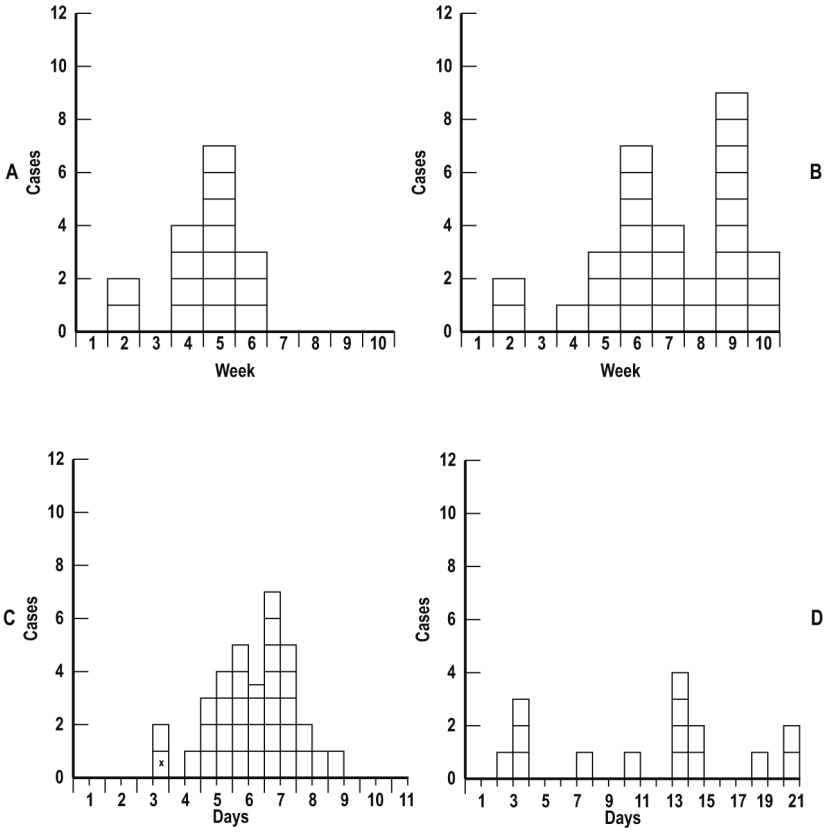


**Fig 4.1.** Epidemic curves: common vs. propagated source outbreak. In practice, other information gathered in the course of investigation is also used to interpret epidemic curves. [Reproduced with permission from the Association for Professionals in Infection Control and Epidemiology, Inc.][3]

## Characteristics of common vs. propagated sources

(See Figure 4.1)

### Common source

1. Curve approximates to a normal distribution curve if there are enough cases and if they are limited to a short exposure with maximum incubation of few days (common source).
2. Exposure may be continuous or intermittent; intermittent exposure to a common source produces a curve with irregularly spaced peaks.

### Propagated source

1. Cases occur over a long period.
2. Explosive epidemics due to person-to-person transmission may occur (i.e., chickenpox); if secondary and tertiary cases occur, intervals between peaks usually approximate to the average incubation period.

## Determination of the probable period of exposure of cases in a common-source outbreak

(See Figure 4.2)

### Necessary information

1. Specific disease involved
2. Either mean or median, or minimum and maximum, incubation period(s) for the specific disease
3. Dates of onset of cases

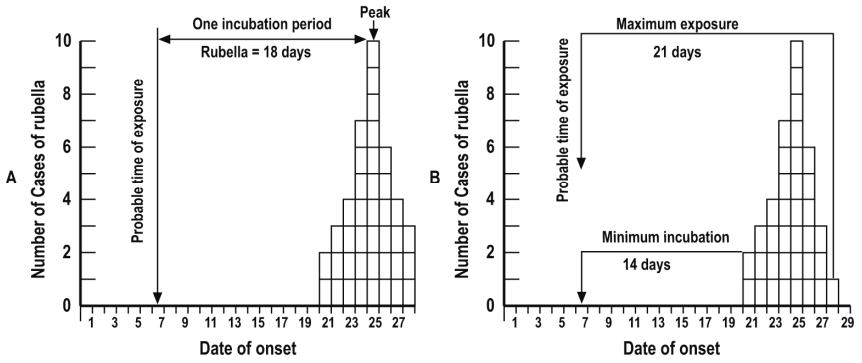


**Fig 4.2** Determining the probable period of exposure in common source outbreaks using mean or median incubation period (A) or minimum and maximum incubation periods (B). [Reproduced with permission from the Association for Professionals in Infection Control and Epidemiology, Inc.][3]

**Draw epidemic curve and calculate by either of the following methods.**

1. Using the mean or median incubation period: identify the peak of the epidemic or the date of onset of the median case; count back into one incubation period.
2. Using minimum and maximum incubation periods: start with the first case identified and count back in time the minimum incubation period; then using the last case, count back in time the maximum incubation period.

## Control measures and follow up

Interventions commonly used to control an outbreak are as follows:

**1. Control the source of the pathogen.**

- Remove the source of contamination, e.g., discard contaminated food.
- Remove persons from exposure, e.g., keep people from being exposed to mosquito bites to prevent West Nile virus encephalitis.
- Inactivate or neutralize pathogen, e.g., disinfect and filter contaminated water.
- Treat infected persons.

**2. Interrupt transmission.**

- Patient isolation and barrier precautions determined by infectious agents.
- Disinfect environmental sources of transmission, e.g., milk, water, air.
- Control mosquito or vector transmission using skin repellents, improve personal sanitation (e.g., washing hands).

**3. Control or modify the host response to exposure.**

Immunise susceptible hosts, use prophylactic chemotherapy, modify behaviour or use a barrier (e.g., prevent exposure to mosquito bites by wearing protective clothing and repellents).

## Why Some Outbreaks End

Outbreaks may end for the following reasons:

- No more susceptible individuals. Everybody who was susceptible got the disease.
- No more exposure to the source. The individuals move away from the source of infection.
- No more source of contamination. The source of contamination ends (e.g., all the contaminated food is consumed).
- Individuals decrease their susceptibility. People get naturally immunised or are vaccinated or use preventive measures to avoid disease.
- The pathogen becomes less pathogenic. Sometimes when germs (bacteria, viruses) pass from one individual to another they change or mutate, becoming less pathogenic, or less capable of producing disease.

## Conclusion

Performing surveillance, monitoring trends and detecting outbreaks, investigating outbreaks and eliminating sources, providing technical assistance and education to the medical community and designing and implementing special epidemiologic studies are important for controlling outbreaks of communicable diseases.

## Acknowledgement

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