Chapter 5

Outbreak Management

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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, 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 outlines what an epidemiologist does when investigating disease patterns. Analysis of these patterns leads to an understanding of their spread and control.[1] Outbreaks should be identified and investigated promptly because of morbidity, cost, and institutional image.[2] Outbreak investigations may lead to improved patient care.

Early identification of an outbreak is also important to limit spread by healthcare 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 justify control measures.

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., postsurgical group A streptococcus infection) 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 (also known as "baseline incidence") represent most preventable healthcare-associated infections.

Relative risk: 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. If the RR =1, the incidence in the exposed group is the same as in the non-exposed; thus there is no association between exposure and disease. A 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. A 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) is often useful. The definition should differentiate between infection and colonisation.

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

Why Epidemics Occur

There are many causes of outbreaks, four common ones are:

1. When susceptible individuals travel into an area where the infectious disease 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 food, water, or other vehicles become contaminated by an infectious agent not normally present (e.g., anthrax spores placed into mail as a terrorist act).
3. When a pre-existing infection occurs in an area of low endemicity and reaches susceptible persons as a result of new or unusual social, behavioural, 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 immunosup-

pression (e.g., cancer treatment, malnutrition, or diseases such as acquired immunodeficiency syndrome).

In healthcare settings, outbreaks are typically related to hand or environmental contamination, invasive devices, and procedures. The mode of transmission of outbreak pathogens in health care settings typically can be categorised as 1) common source, 2) human reservoir, 3) cross-infection (person to person), 4) airborne, 5) other environmental (e.g., fomite or introduction of a new type of medical device), or 6) uncertain.[3]

Types of Outbreaks

1. Community-acquired: e.g., food-borne infections, measles.
2. Healthcare-associated: when two or more cases of infection appear to be epidemiologically related or infections occur above the background rate or an unusual microbe is recognised.[4]

Investigating an Outbreak

Purpose and objectives of an outbreak investigation

The purpose of an epidemic or outbreak investigation is to prevent further transmission or outbreaks of the disease. The three main objectives are:

1. Identify the causal 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; and
3. Formulate recommendations to prevent further transmission.

Outbreak investigation tasks

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

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 from national surveillance systems or the literature (however, these data may not be applicable to the local situation).

Determine if there were changes in case finding or diagnostics

New techniques or laboratory tests may increase identification when historically cases would not have been identified, providing a new 'baseline' of disease.

Establish diagnosis of reported cases (identify agent)

Define cases based on the following common factors:

1. Population risk factors: e.g., age, race, sex, socioeconomic status.
2. Clinical data: e.g., onset of signs and symptoms, frequency and duration of clinical features associated with the outbreak, treatments, and devices.
3. Laboratory results.

Search for other cases that may have occurred retrospectively or concurrently

Collect critical data and specimen information from:

1. Laboratory reports
2. Medical records

3. Patient charts
4. Physicians and nursing staff
5. Public health data

Characterise cases

1. Assemble and organise available information in terms of time, place, and person for analysis.

   a. Time

      1) The exact period of the outbreak.
      2) The probable period of exposure.
      3) Date of onset of illness for cases; draw an epidemic curve.
      4) Is the outbreak common source (single point source) or propagated (on-going transmission)?

   b. Place

      1) Service, ward, operating room.
      2) Clustering of cases.

   c. Person

      1) Patient characteristics (age, sex, underlying disease).
      2) Possible exposures (surgery, nursing and medical staff, infected patients).
      3) Therapy (invasive procedures, medications, antibiotics).

From this information, the population at risk can be accurately described.

2. Calculate rates

   a. Incidence rate: The number of new cases occurring in the population during a specified time / number of persons exposed to the risk of developing the disease during that time.[1]
   b. 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, or occupational exposure). [2]

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 most cases.

Test the hypothesis

This may require a special study.

1. 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.

2. Examples of situations that should be studied:
    a. Infection associated with a commercial product.
    b. Infection associated with considerable morbidity (e.g., bacteraemia) and/or mortality.
    c. 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 younger individuals eating in the popular cafeteria are the ones who should be investigated regarding specific foods eaten.
3. Analyse data derived from case investigation. Determine sources of transmission and risk factors associated with disease.
4. Refine hypothesis and carry out additional studies if necessary.

Institute control measures and follow-up

The aims are:

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

Control measures are determined by the results of the initial analysis in consultation with appropriate professionals (i.e., infection prevention and control staff, epidemiologist, clinicians, microbiologists, nurses, or technicians). Control measures will vary depending on the agent, the mode of transmission, and observations.[3] (See Table 5.1)

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

Table 5.1. Immediate control measures for outbreak management

Evaluate efficacy of control measures

1. Cases cease to occur or return to endemic level.
2. No change (re-evaluate cases).
3. Use the opportunity of an outbreak to review and correct other health care practices which could contribute to future outbreaks.

Communicate and write a final report

During the investigation of an outbreak, timely, up-to-date information must be communicated to 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 should be prepared describing the outbreak, interventions, and effectiveness, and summarising the contribution of each team member participating in the investigation. It should include recommendations to prevent any future occurrence.

Determining the Source of Infection

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.[5] The reasons for constructing an epidemic curve include:

1. To determine whether the source of infection was common, propagated, or both. In some instances, the shape of the epidemic curve will provide information that can help identify the mode of transmission.
2. To identify the probable time of exposure of the cases to the source(s) of infection.
3. To identify the probable incubation period.
4. 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.[4]

Characteristics of common vs. propagated sources

In practice, other information gathered in the course of investigation is used to interpret epidemic curves. (See Figure 5.1) Information required includes the specific disease involved, either mean or median, or minimum and maximum, incubation period(s) for the specific disease, and dates of onset of cases.

Draw epidemic curve and calculate incubation period

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.

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 a few days (common source).
2. Exposure may be continuous or intermittent; intermittent exposure to a common source produces a curve with irregularly spaced peaks.

3. Determination of the probable period of exposure of cases in a common-source outbreak (See Figure 5.2)

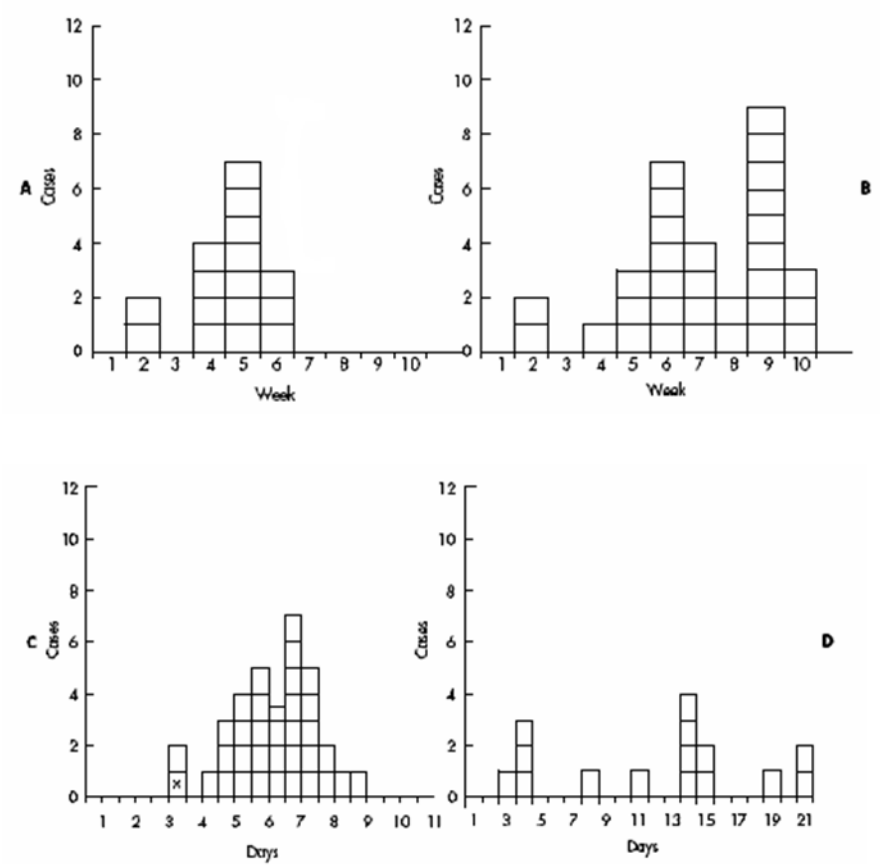

Figure 5.1. Epidemic curves: common vs. propagated source outbreak. [Reproduced with permission from Checko PJ. Outbreak Investigation IN: *APIC Text of Infection Control and Epidemiology*. 2nd Ed. Association for Professionals in Infection Control and Epidemiology, Washington, DC. 2005; 4: 1-10]

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).

Propagated source

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

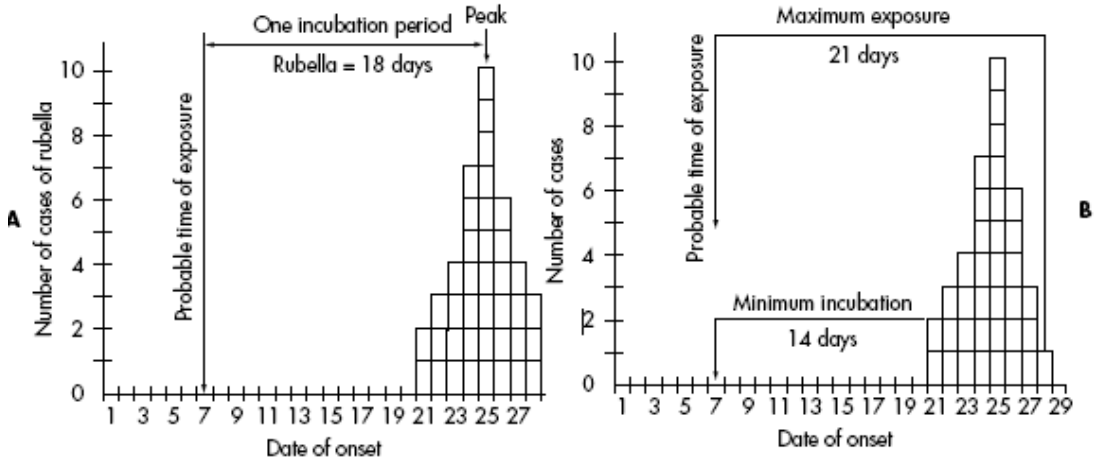

Figure 5.2 Determining the probable period of exposure in common source outbreaks using mean or median incubation period (A) or minimum and maximum incubation periods (B). [Reproduced with permission from Checko PJ. Outbreak Investigation IN: *APIC Text of Infection Control and Epidemiology*. 2nd Ed. Association for Professionals in Infection Control and Epidemiology, Washington, DC. 2005; 4: 1-10]

Control Measures and Follow-up

Interventions commonly used to control an outbreak are as follows:

- 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 neutralise pathogen, e.g., disinfect and filter contaminated water.
- Treat infected persons.
- Interrupt transmission.
    1. Use patient isolation and barrier precautions determined by infectious agent.
    2. Disinfect environmental sources of transmission, e.g., milk, water, or air.
    3. Control mosquito or vector transmission using skin repellents, improve personal sanitation (e.g., washing hands).
- Control or modify the host response to exposure. Immunise susceptible hosts, use prophylactic chemotherapy, modify behaviour, or use a barrier.

Why Some Outbreaks End

Outbreaks may end for the following reasons:

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

Conclusion

Performing surveillance and monitoring trends are important for 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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Further Reading

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