Session I
Recognizing an Outbreak

Session Overview
• Overview of the steps of an outbreak investigation
• Case definition
• Case finding
• Verification of diagnosis
• Orientation of data by person, place, and time
Learning Objectives

• Identify steps of an outbreak investigation
• Develop and use a case definition
• Apply the process of case finding in an outbreak
• Identify methods used to orient data by person, place, and time
• Develop and interpret epidemic curves

What is an outbreak?

The occurrence of more cases of a disease than expected for a particular place and time

Outbreak Surveillance Sources

• Laboratory-confirmed reports of notifiable diseases
• Clinician reports of notifiable disease
• Concerned parent/citizen reports to health department
• Media
Basic Steps of an Outbreak Investigation

1. Verify the diagnosis and confirm the outbreak
2. Define a case and conduct case finding
3. Tabulate and orient data: time, place, person
4. Take immediate control measures
5. Formulate and test hypothesis
6. Plan and execute additional studies
7. Implement and evaluate control measures
8. Communicate findings

Exceptions to the Rule

- Basic steps provide a model for systematic outbreak investigations.
- No two outbreaks are alike!
- Steps of an outbreak could…
  - occur in a different order
  - occur simultaneously
  - be repeated after new information is discovered

Disease Surveillance: Case Report

What questions would you ask an ill person?

WHO: age, sex, occupation, any others ill
WHAT: physical condition, symptoms, medication, and medical care sought
WHEN: when did the affected become ill
WHERE: city/school, address, telephone number of ill persons
WHY/HOW: suspected cause of illness, risk factors, modes of transmission, hints from those who did not become ill
Disease Surveillance: What next?

• File the report and stop?
• Investigate further?

Deciding to Investigate

• Ideally, all reports of possible outbreaks should be investigated to:
  – Prevent other persons from becoming ill
  – Identify potentially problematic practices
  – Add to the knowledge of infectious diseases

Why Investigate?

• Surveillance detects increase in cases of disease
• Characterize the problem
• Prevention and control
• Research and answer scientific questions
• Train epidemiologists
• Political / legal concerns
Maybe you should...

• If illness is severe (life-threatening)
• If there are confirmed clusters/large numbers of a similar illness
• If foodborne illness is in a food handler
• If illness is associated with commercially-distributed food
• If there is outside pressure to investigate (media, politicians)

Maybe you shouldn’t...

• If signs/symptoms or confirmed diagnoses among the affected suggest they might not have the same illness
• If ill persons are not able to provide adequate information for investigation
• If confirmed diagnosis and/or clinical symptoms are not consistent with the related exposures
• If there are repeated complaints made by the same individual(s) for which prior investigations revealed no significant findings

Verify the Diagnosis

• Pathogen identification will help identify the potential incubation period
• Crucial to know the incubation period for hypothesis generation
• Don’t need to wait for laboratory diagnosis to proceed
Verify the Diagnosis

Evaluate:
✓ Predominant signs and symptoms
✓ Incubation period
✓ Duration of symptoms
✓ Suspected food
✓ Suspected toxin, virus, or bacteria
✓ Laboratory testing of stool, blood, or vomitus

Verify the Diagnosis

• Potential reasons for negative laboratory results:
  – Mishandling of specimen resulting in death of the pathogen (during storage, transport, processing, or culture)
  – Specimens collected too late in the illness
  – Illness could be due to an organism that wasn’t tested for

Case Definition

A standard set of criteria for deciding whether an individual should be classified as having the disease of interest, including:
  – Clinical criteria (signs, symptoms, and laboratory tests)
  – Person, place, and time criteria
Case Definition

- The case definition can be modified as more data are obtained
- Do not include the hypothesis being tested in the case definition

Case Finding

- Contact local care providers
- Contact schools, large businesses
- Contact state health department / neighboring health departments
- Ask case-patients if they know of others who are ill

Descriptive Epidemiology

- Comprehensively describes the outbreak
  - Person
  - Place
  - Time
Descriptive Epidemiology: Person

Data summarization for descriptive epidemiology of the population

- Line listings
- Graphs
  - Bar graphs
  - Histograms

Line Listing

<table>
<thead>
<tr>
<th>Case #</th>
<th>Report Date</th>
<th>Onset Date</th>
<th>Physician Diagnosis</th>
<th>NI</th>
<th>V</th>
<th>J</th>
<th>VHIgM</th>
<th>Sex</th>
<th>Age</th>
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<td>17</td>
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<td>0</td>
<td>1</td>
<td></td>
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</tbody>
</table>

Bar Graph

Number of cases who consumed half dates, by gender (VHIgM)
Descriptive Epidemiology: Person

• Measures of central tendency
  – Mean
  – Median

Measures of Central Tendency

Mean (Average)
The sum of all values divided by the number of values

Example:
1. Cases 7, 10, 8, 5, 5, 37, 9 years old
2. Mean = (7+10+8+5+5+37+9)/7
3. Mean = 11.6 years of age
Measures of Central Tendency

Median (50th percentile)
The value that falls in the middle position when the measurements are ordered from smallest to largest

Example:
1. Ages 7, 10, 8, 5, 5, 37, 9
2. Ages sorted: 5, 5, 7, (8), 9, 10, 37
3. Median age = 8

Calculate a Median Value
If the number of measurements is odd:

Median = value with rank \((n+1)/2\)

- 5, 5, 7, 8, 9, 10, 37
- \(n = 7\), \((n+1)/2 = (7+1)/2 = 4\)
- The 4th value = 8

Where \(n\) = the number of values

Calculate a Median Value
If the number of measurements is even:

 Median = average of the two values with:
- rank of \(n/2\) and
- rank of \(n/2 + 1\)

Where \(n\) = the number of values

- 5, 5, 7, 8, 9, 10, 12, 37
- \(n = 8\); \((8/2) = 4\). So “8” is the first value
- \((8/2)+1 = 5\), so “9” is the second value
- \((8+9)/2 = 8.5\)
- The median value = 8.5
Descriptive Epidemiology: Place

- Spot map
  - Shows where cases live, work, spend time
  - If population size varies between locations being compared, use location-specific attack rates instead of number of cases

Descriptive Epidemiology: Place

Source: [cdc.gov](http://www.cdc.gov)

Descriptive Epidemiology: Time

![Bar chart showing the number of cases per day]

Source: [cdc.gov](http://www.cdc.gov)
Descriptive Epidemiology: Time

- An epidemic curve (epi curve) is a graphical depiction of the number of cases of illness by the date of illness onset
- Can provide information on the outbreak’s:
  - Pattern of spread
  - Magnitude
  - Outliers
  - Time trend
  - Exposure and/or disease incubation period

Epidemic Curves

The overall shape of the epi curve can reveal the type of outbreak (the pattern of spread)

- Common source
  - Intermittent
  - Continuous
  - Point source
- Propagated

Epidemic Curves: Common Source

- People are exposed to a common harmful source
- Period of exposure may be brief (point source), long (continuous) or intermittent
Epi Curve: Common Source Outbreak with *Intermittent* Exposure

Epi Curve: Common Source Outbreak with *Continuous* Exposure

Epi Curve: Common Source Outbreak with *Point Source* Exposure
Epi Curve: Propagated Outbreak

Pattern of Spread

Epidemic Curves

Magnitude

Epidemic Curves: Time Trend

Provide information about the time trend of the outbreak

• Consider:
  – Date of illness onset for the first case
  – Date when the outbreak peaked
  – Date of illness onset for the last case
Epidemic Curves: Incubation Period

• If the timing of the exposure is known, epi curves can be used to estimate the incubation period of the disease

• The time between the exposure and the peak of the epi curve represents the median incubation period

Epidemic Curves: Period of Exposure

• In common source outbreaks with known incubation periods, epi curves can help determine the average period of exposure
  – Find the average incubation period for the organism and count backwards from the peak case on the epi curve
  – Find the minimum incubation period for the organism and count backwards from the earliest case on the epi curve

Calculating Exposure Period

Creating an Epidemic Curve

- Provide a descriptive title
- Label each axis
- Plot the number of cases of disease reported during an outbreak on the y-axis
- Plot the time or date of illness onset on the x-axis
- Include the pre-epidemic period to show the baseline number of cases

Epi Curve for a Common Source Outbreak with Continuous Exposure

X-axis considerations
Choice of time unit for x-axis depends upon the incubation period:
- Begin with a unit approximately one quarter the length of the incubation period

Example:
1. Mean incubation period for influenza = 36 hours
2. 36 x ¼ = 9
3. Use 9-hour intervals on the x-axis for an outbreak of influenza lasting several days
Creating an Epidemic Curve

X-axis considerations

• If the incubation period is not known, graph several epi curves with different time units

• Usually the day of illness onset is the best unit for the x-axis

Epi Curve

X-Axis Considerations

X-axis unit of time = 1 week
X-axis unit of time = 1 day

Session Summary

An outbreak is the occurrence of more cases of disease than expected for a given place and time. There are basic steps that can be followed to investigate an outbreak.

The decision whether or not to investigate an outbreak depends on several factors.

Verification of the diagnosis allows for identification of the incubation period and is necessary for hypothesis generation.

A case definition is needed to identify case-patients related to the outbreak and to conduct additional case finding.
Session Summary

Descriptive epidemiology: 1) Familiarizes the investigator with data about time, place, and person; 2) Comprehensively describes the outbreak; and 3) Is essential for hypothesis generation.

Measures of central tendency provide a means of assessing the distribution of data. Measures include mean and median.

Epi curves, spot maps, and line listings are all ways in which you can generate and review the time, place, and person elements – respectively – of descriptive statistics.

References and Resources


References and Resources


