Public Health 101 Series



Introduction to Epidemiology

Instructor name
Title
Organization

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Course Topics

Introduction to Epidemiology

1. A Public Health Approach
2. What Is Epidemiology?
3. Key Concepts and Terms
4. Calculating Rates
5. Approach and Methodology
6. Data Sources and Study Design
7. Investigating an Outbreak

Learning Objectives

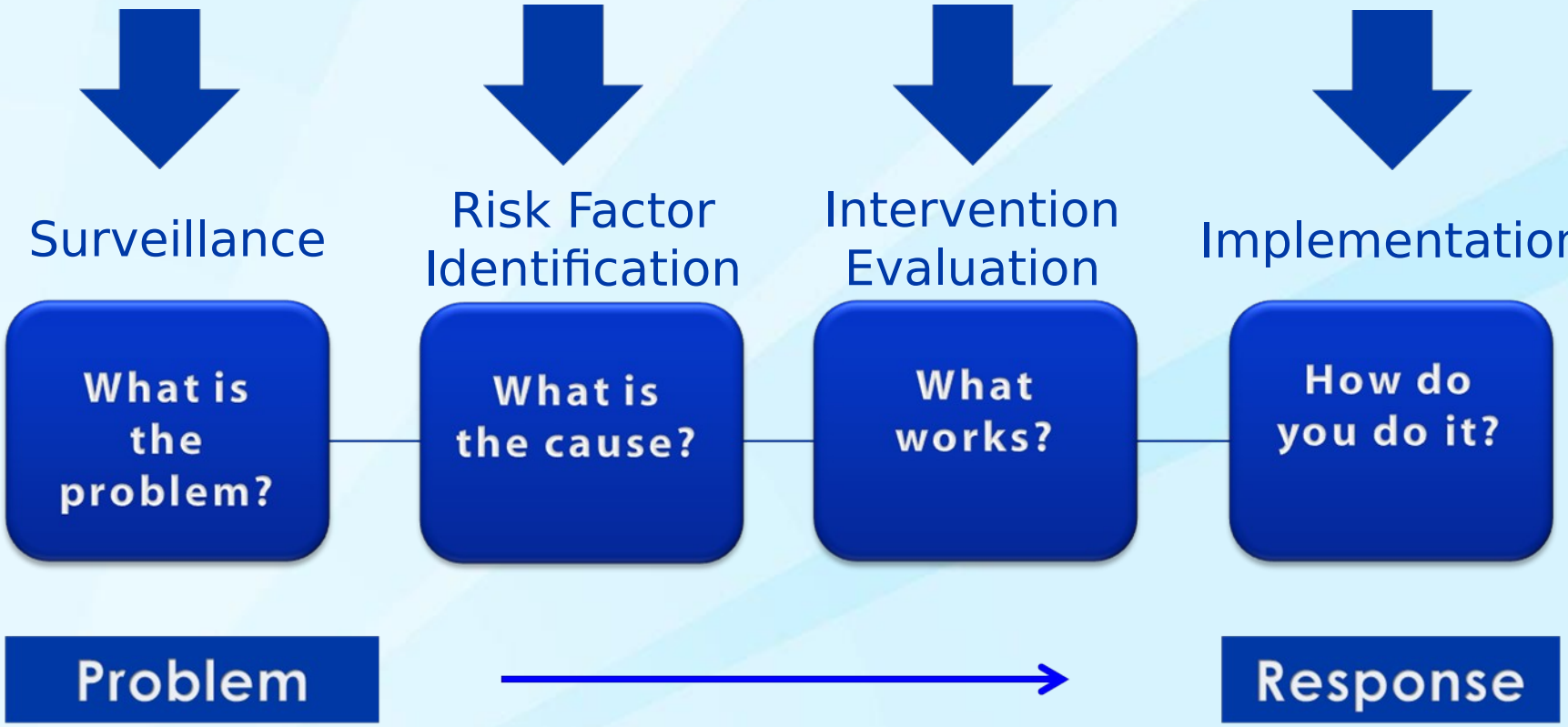
After this course, you will be able to

- define epidemiology
- describe basic terminology and concepts of epidemiology
- identify types of data sources
- identify basic methods of data collection and interpretation
- describe a public health problem in terms of time, place, and person
- identify the key components of a descriptive epidemiology outbreak investigation

Topic 1
A Public Health Approach



A Public Health Approach



Public Health Core Sciences



Topic 2
What Is Epidemiology?



Epidemiology — Defined



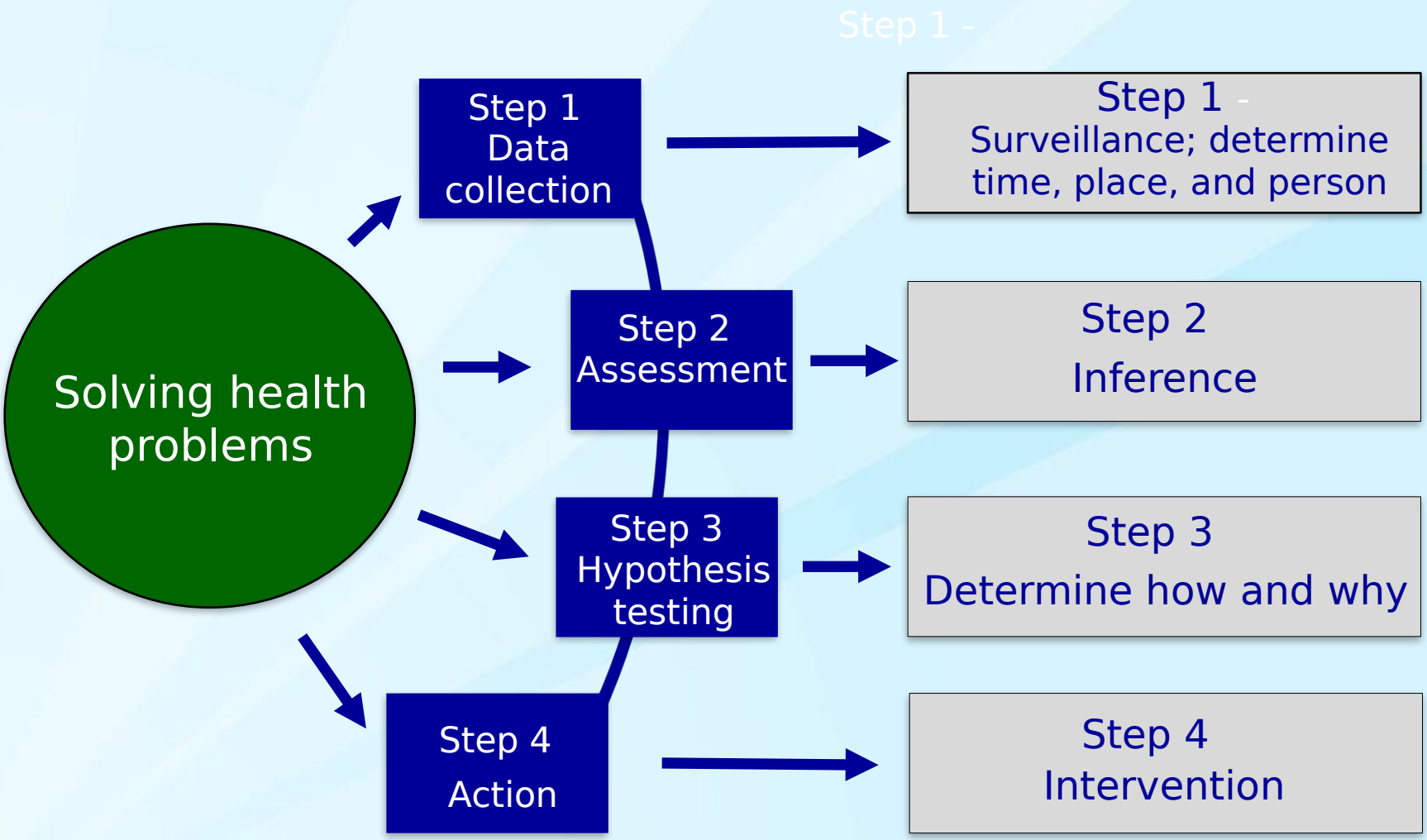
Study of the distribution and determinants of health-related states among specified populations and the application of that study to the control of health problems

Adapted from: Last JM, ed. A dictionary of epidemiology. 2nd ed. Toronto, Canada: Oxford University Press; 1988.

Epidemiology Purposes in Public Health Practice

- Discover the agent, host, and environmental factors that affect health
- Determine the relative importance of causes of illness, disability, and death
- Identify those segments of the population that have the greatest risk from specific causes of ill health
- Evaluate the effectiveness of health programs and services in improving population health

Solving Health Problems



Knowledge Check

All of the following illustrate the purpose of epidemiology in public health, except

A. identifying populations who are at risk for certain diseases.

B. assessing the effectiveness of interventions.

✓ C. providing treatment for patients in clinical settings.

D. determining the importance of causes of illness

Knowledge Check

Epidemiologists use a model for studying infectious disease and its spread that involves the microbe that causes the disease, the organism that harbors the disease, and the external factors that cause or allow disease transmission. This is also known as

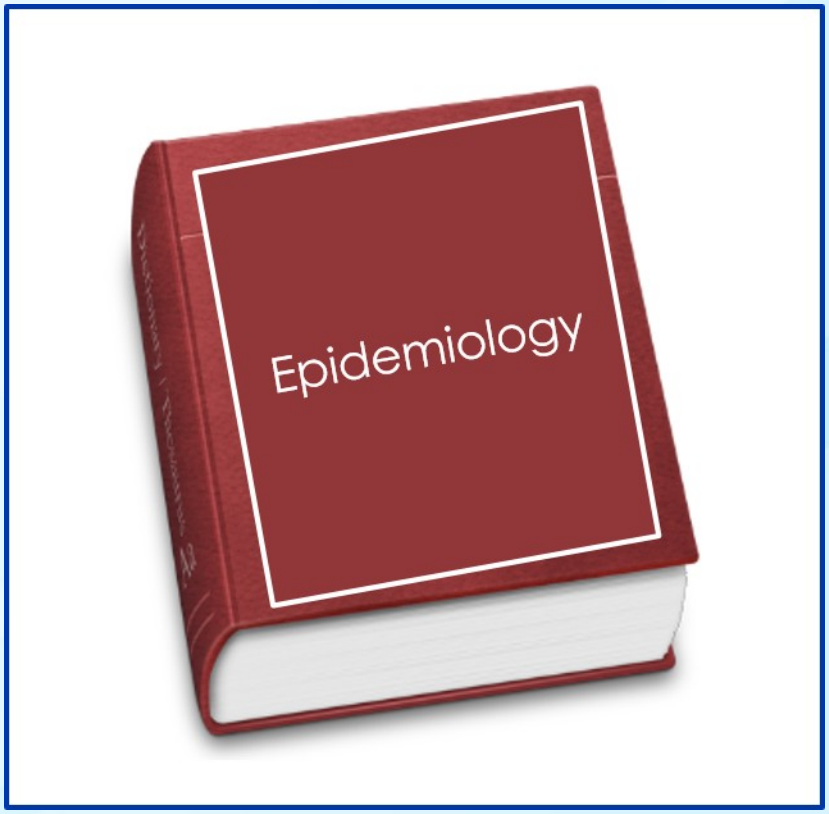
A. host, vector, and transmission.

B. transmission, host, and environment.

✓ C. host, agent, and environment.

D. organism, transmission, and environment.

Topic 3
Epidemiology Key Terms



Epidemiology Key Terms

epidemic or outbreak: disease occurrence among a population that
is in excess of what is expected in a given time and place.

cluster: group of cases in a specific time and place that might be more than expected.

endemic: disease or condition present among a population at all times.

pandemic: a disease or condition that spreads across regions.

rate: number of cases occurring during a specific period; always dependent on the size of the population during that period.

Knowledge Check

Match each term with the correct example.

A. endemic B. pandemic C. epidemic

A. endemic

1. Malaria is present in Africa at all times because of the presence of infected mosquitoes. Malaria is _____ in Africa.

C. epidemic

2. The Ebola virus in parts of Africa is in excess of what is expected for this region. This virus is a/an _____.

B. pandemic

3. HIV/AIDS is one of the worst global diseases in history. It is a/an _____.

Knowledge Check

Choose the correct answer.

A. distribution B. cluster C. determinant

In March 1981, an outbreak of measles occurred among employees at Factory X in Fort Worth, Texas.

This group of cases in this specific time and place can be described as a _____.

cluster

Topic 4
Calculating Rates



Comparing Population Characteristics



Rates help us compare health problems among different populations that include two or more groups who differ by a selected characteristic

Rate Formula

To calculate a rate, we first need to determine the frequency of disease, which includes

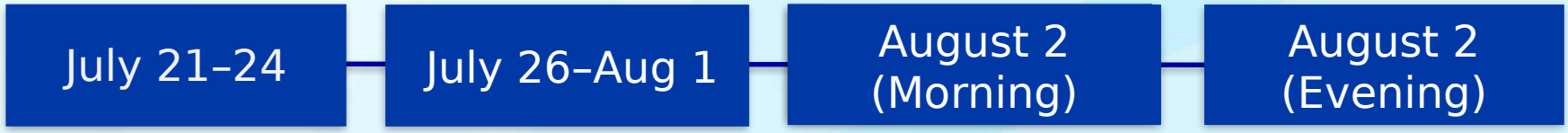
- the number of cases of the illness or condition
- the size of the population at risk
- the period during which we are calculating the rate

$$\text{Rate (\%)} = \frac{\text{number of cases}}{\text{population at risk}} \times 100$$

Scenario: Unexplained Pneumonia

American Legion Convention, Philadelphia, Pennsylvania

Health care provider at a veterans' hospital in Philadelphia calls CDC to report cases of severe respiratory illness among attendees of the American Legion Convention



18 deaths reported among conventioneers

71 additional cases reported

Fraser DW, Tsai, T, Orenstein W, et al. Legionnaires' disease: description of an epidemic of pneumonia. New Engl J Med 1977;297:1189–97.

Legionnaires' Disease, by Age Group

Hotel A Residents

➡ Time: July 21–24, 1976

	Frequency	Unit size	
Age (yrs)	**Sick**	**Total**	**Percentage**
≥39	**3**	**44**	**6.8**
40–49	**9**	**160**	**5.6**
50–59	**27**	**320**	**8.4**
60–69	**12**	**108**	**11.1**
≥70	**11**	**54**	**20.4**
Unknown	**0**	**2**	**0**

Fraser DW, Tsai, T, Orenstein W, et al. Legionnaires' disease: description of an epidemic of pneumonia. New Engl J Med 1977;297:1189–97.

Legionnaires' Disease Rate

Hotel A Residents

Time: July 21–24, 1976

	Frequency	Unit	Rate
Age (yrs)	**Sick**	**Total**	**Percentage**
≥39	3	44	6.8
40–49	9	160	5.6
50–59	27	320	8.4
60–69	12	108	11.1
≥70	11	54	20.4
Unknown	0	2	0

Knowledge Check

On Day 1 of a technology conference in San Diego, 15 presenters who were setting up for their sessions in Annex X became ill with flu-like symptoms. During the course of the conference, 20 participants who attended sessions in Annex X also became ill with the same symptoms.

To begin calculating the rate of this outbreak, investigators should first determine

A. the size of the conference population.

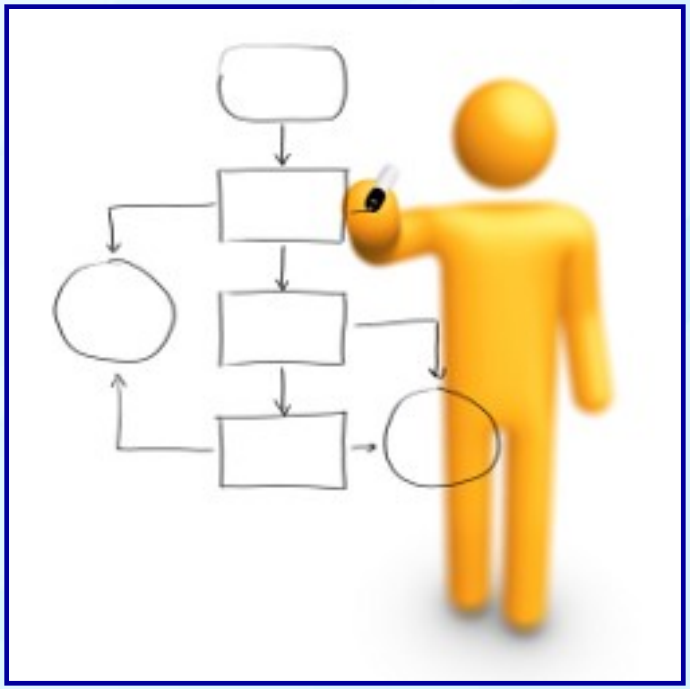
✓ B. the number of cases of illness.

C. the number of days the conference was held.

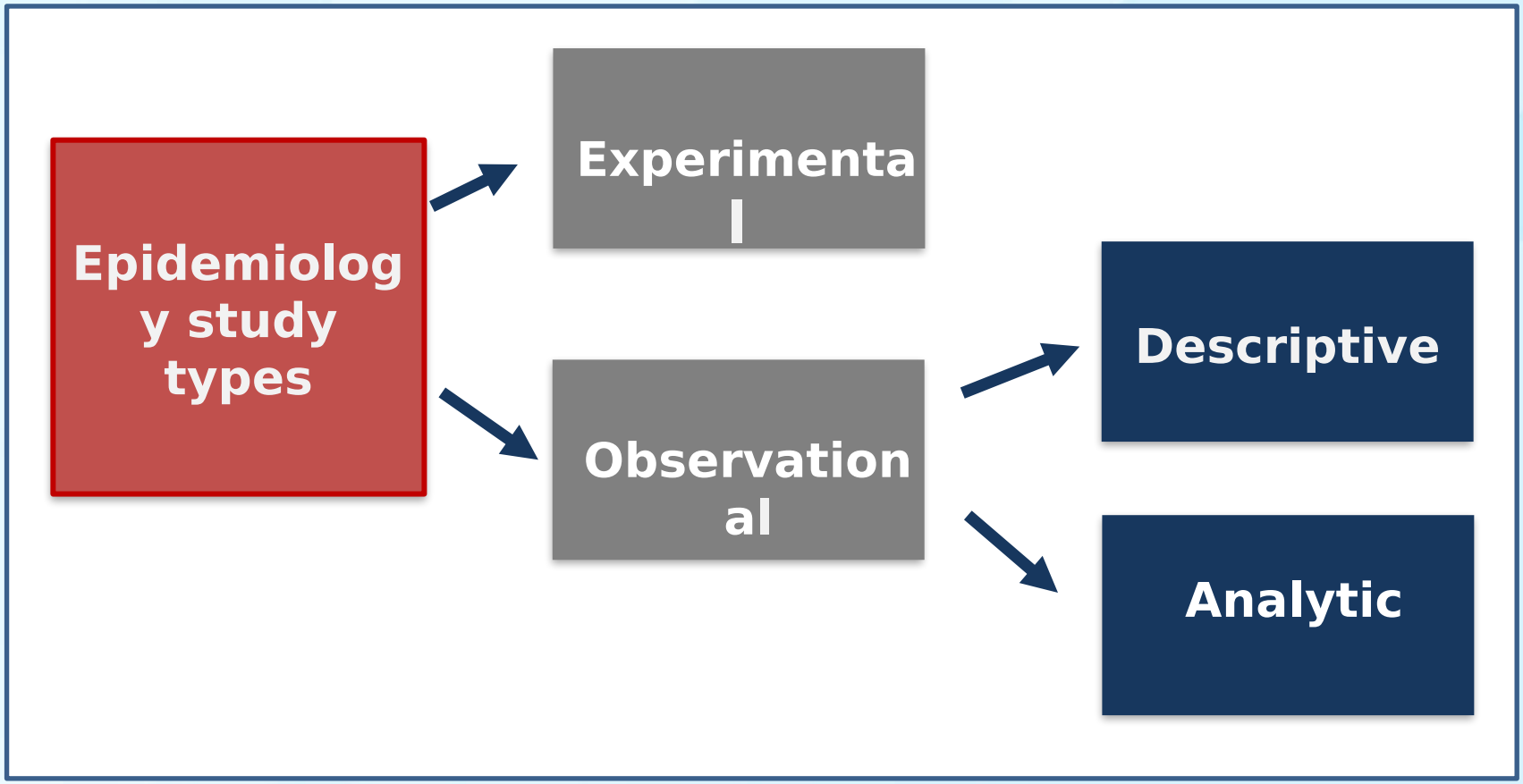
D. the location of the conference.

Topic 5

Epidemiology Approach and Methods



Epidemiology Study Types



Descriptive and Analytic Epidemiology

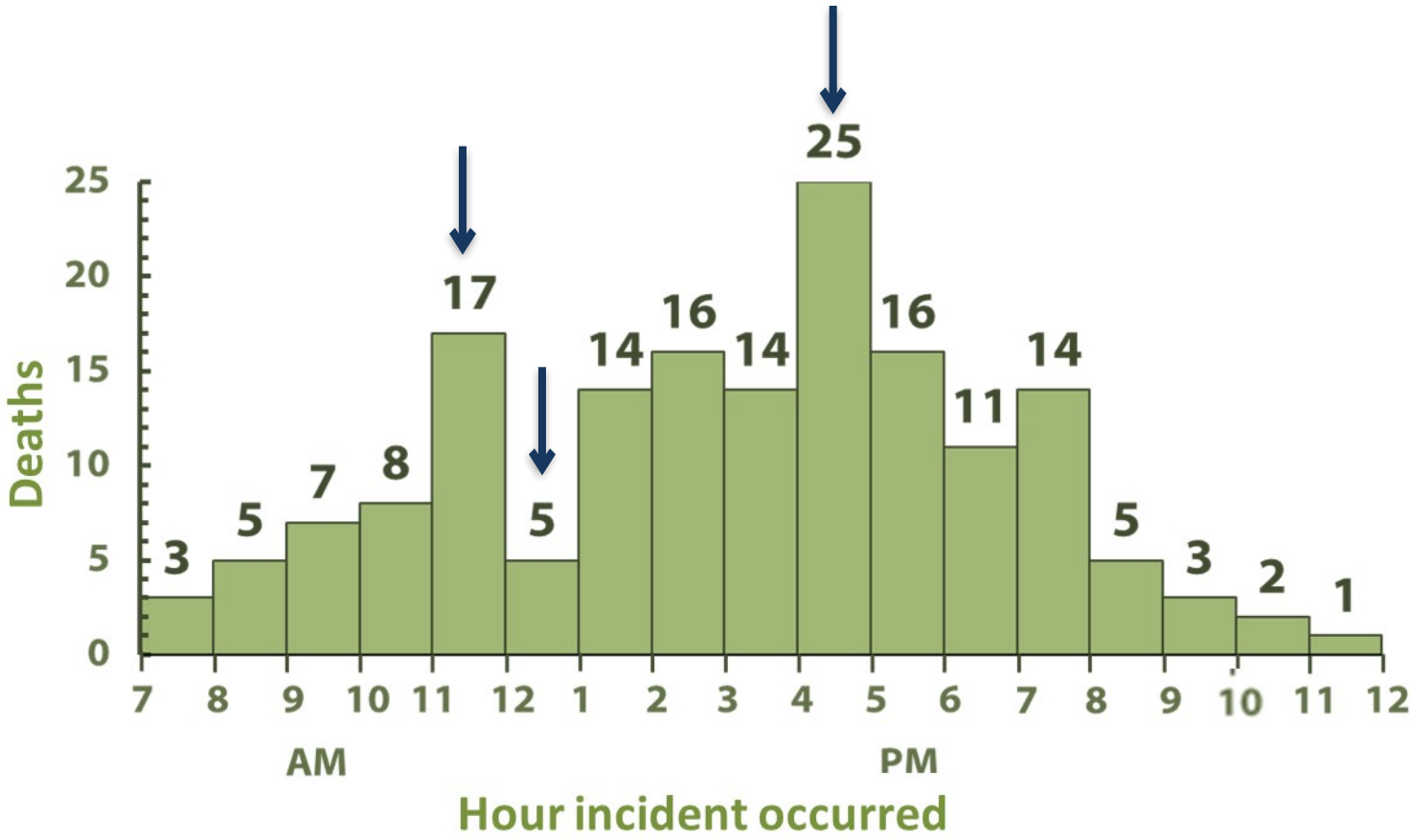
Descriptive epidemiology	Analytic epidemiology
When was the population affected?	How was the population affected?
Where was the population affected?	Why was the population affected?
Who was affected?	

Fatalities Associated with Farm Tractors



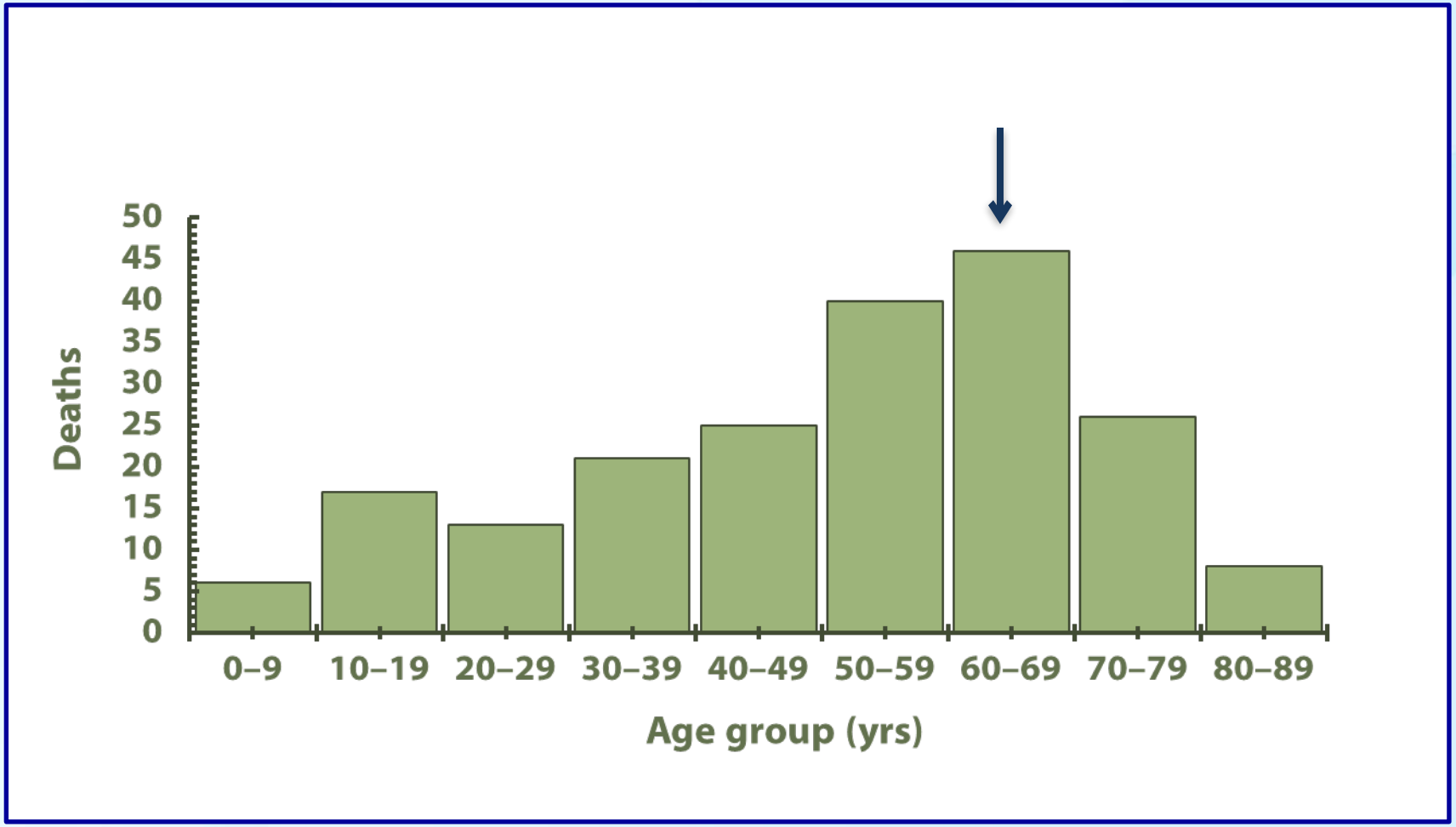
In 1982, the number of farm tractor-associated deaths was described in terms of time, place, and person by using records from an existing surveillance system

Fatalities Associated with Farm Tractors



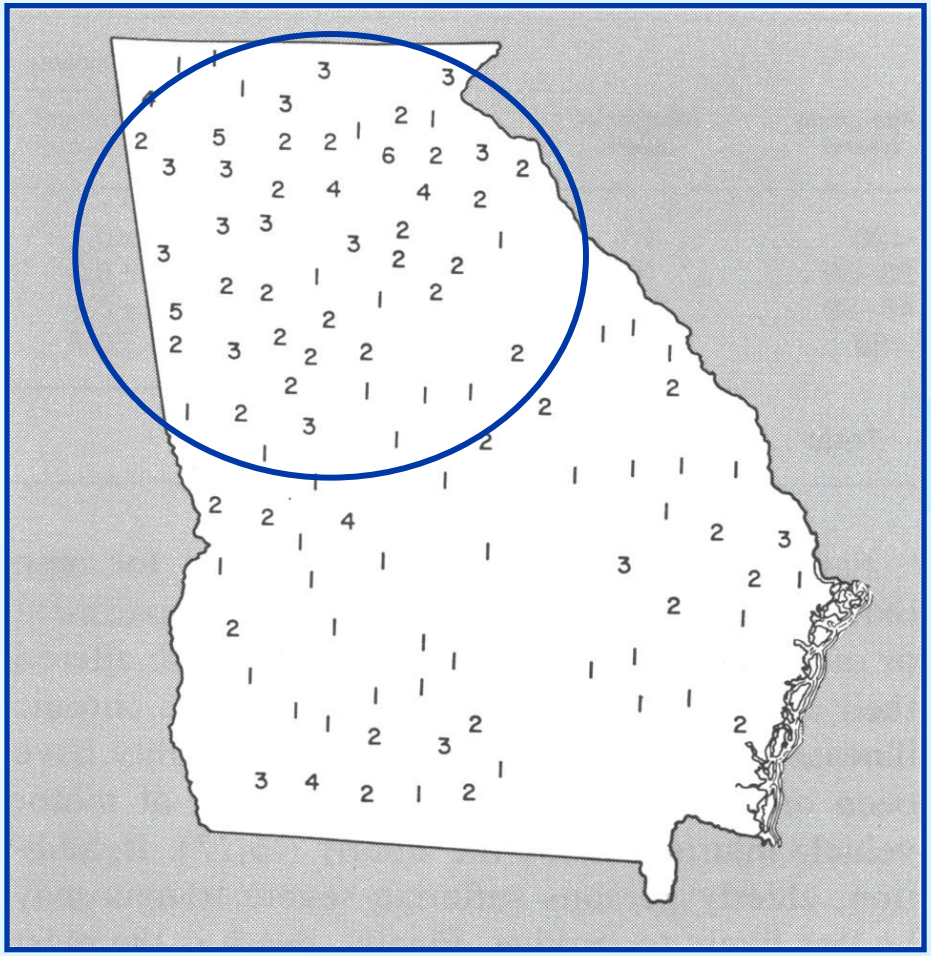
Goodman RA, Smith JD, Sikes RK, et al. Fatalities associated with farm tractor injuries: an epidemiologic study. Public Health Rep 1985;100:329–33.

Fatalities Associated with Farm Tractors



Goodman RA, Smith JD, Sikes RK, et al. Fatalities associated with farm tractor injuries: an epidemiologic study. Public Health Rep 1985;100: 329–33.

Fatalities Associated with Farm Tractors



Goodman RA, Smith JD, Sikes RK, et al. Fatalities associated with farm tractor injuries: an epidemiologic study. Public Health Rep 1985;100:329–33.

Knowledge Check

Choose the correct answer from the following choices:

A. Qualitative B. Experimental C. Observational

C. Observational

An epidemiologist is doing a study on the sleep patterns of college students but does not provide any intervention. What type of study is this?

Knowledge Check

Match each term to the correct example below.

A. Descriptive B. Analytic

B. Analytic 1. A study of heart disease comparing a group who eats healthy foods and exercises regularly with one who does not in an effort to test association

A. Descriptive 2. A study to describe the eating habits of adolescents aged 13–18 years in Community X

Topic 6

Epidemiology Data Sources and Study Design



Data Sources and Collection Methods

Source	Method	Example
Individual persons	• Questionnaire • Survey	• Foodborne illness outbreak • CDC's National Health and Nutrition Examination Survey • Health data on U.S. residents
Environment	• Samples from the environment (river water, soil) • Sensors for environmental changes	• Collection of water from area streams — check for chemical pollutants • Air-quality ratings
Health care providers	• Notifications to health department if cases of certain diseases are observed	• Report cases of meningitis to health department
Nonhealth–related sources (financial, legal)	• Sales records • Court records	• Cigarette sales • Intoxicated driver arrests

Conducting Studies



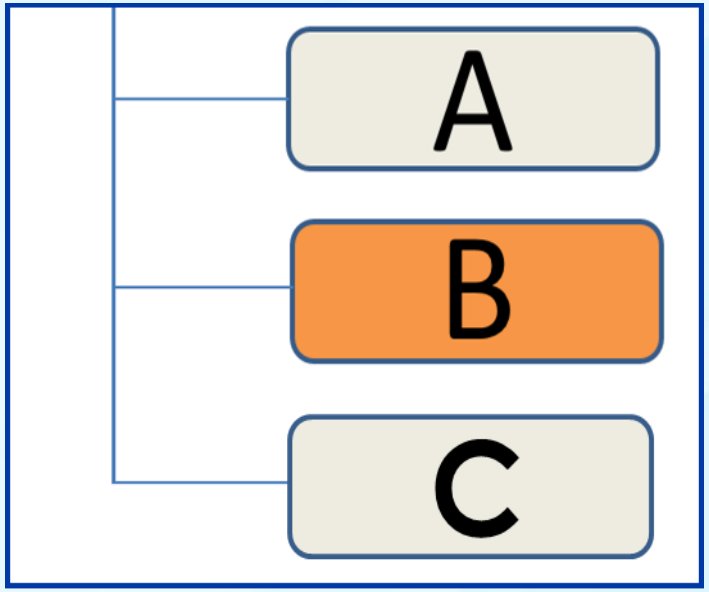
Studies are conducted in an attempt to discover associations between an exposure or risk factor and a health outcome

Study Design — Cross-Sectional Study



Subjects are selected because they are members of a certain population subset at a certain time

Study Design — Cohort Study



Subjects are categorized on the basis of their exposure to one or more risk factors

Study Design Type — Case-Control Study



Subjects identified as having a disease or condition are compared with subjects without the same disease or condition

Knowledge Check

Which of the following are examples of a health-related source of data collection?

A. Intoxicated driver arrests.

✓ B. Electronic health records.

✓ C. Measurement of toxins in a river.

D. Medical board action against a physician.

Knowledge Check

Match each study with the correct definition.

A. Cross-Sectional B. Cohort C. Case-Control

C. Case-Control

1. Subjects with diabetes are compared with subjects without diabetes.

A. Cross-Sectional

2. A study of women aged 50–60 years in a community located close to a nuclear power facility.

B. Cohort

3. Subjects who have received nutritional counseling and who have exercised twice a week are compared with subjects who have not.

Topic 7

Investigating an Outbreak



Outbreak Investigation

Ten steps are involved in outbreak investigations, including



- establishing the existence of an outbreak
- preparing for fieldwork
- verifying the diagnosis
- defining and identifying cases
- using descriptive epidemiology
- developing hypotheses
- evaluating the hypotheses
- refining the hypotheses
- implementing control and prevention measures
- communicating findings

Outbreak Investigation — Steps 1 and 2



Step 1 — Establishing the existence of an outbreak

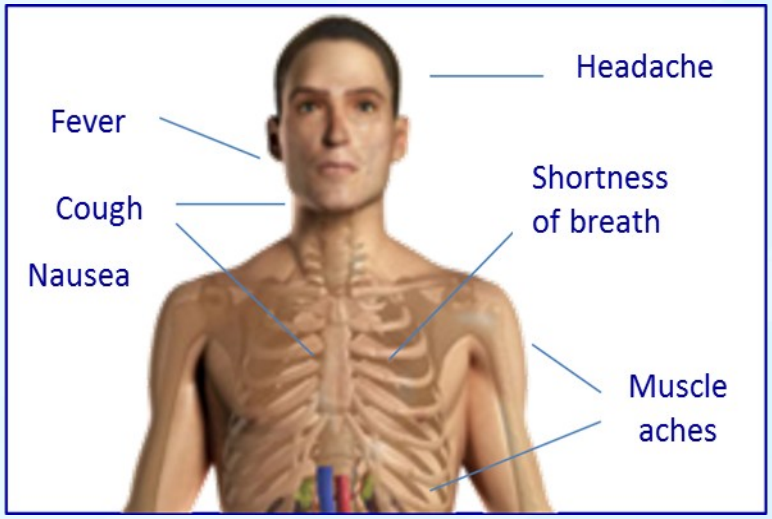
- Use data from data sources

Step 2 — Preparing for field work

- Research the disease
- Gather supplies and equipment
- Arrange travel

Fraser DW, Tsai, T, Orenstein W, et al. Legionnaires' disease: description of an epidemic of pneumonia. New Engl J Med 1977;297 1189–97.

Outbreak Investigation — Steps 3 and 4



Step 3 — Verifying the diagnosis

- Speak with patients
- Review laboratory findings and clinical test results

Step 4 — Defining and identifying cases

- Establish a case definition by using a standard set of criteria

Fraser DW, Tsai, T, Orenstein W, et al. Legionnaires' disease: description of an epidemic of pneumonia. New Engl J Med 1977;297 1189–97.

Outbreak Investigation — Step 5

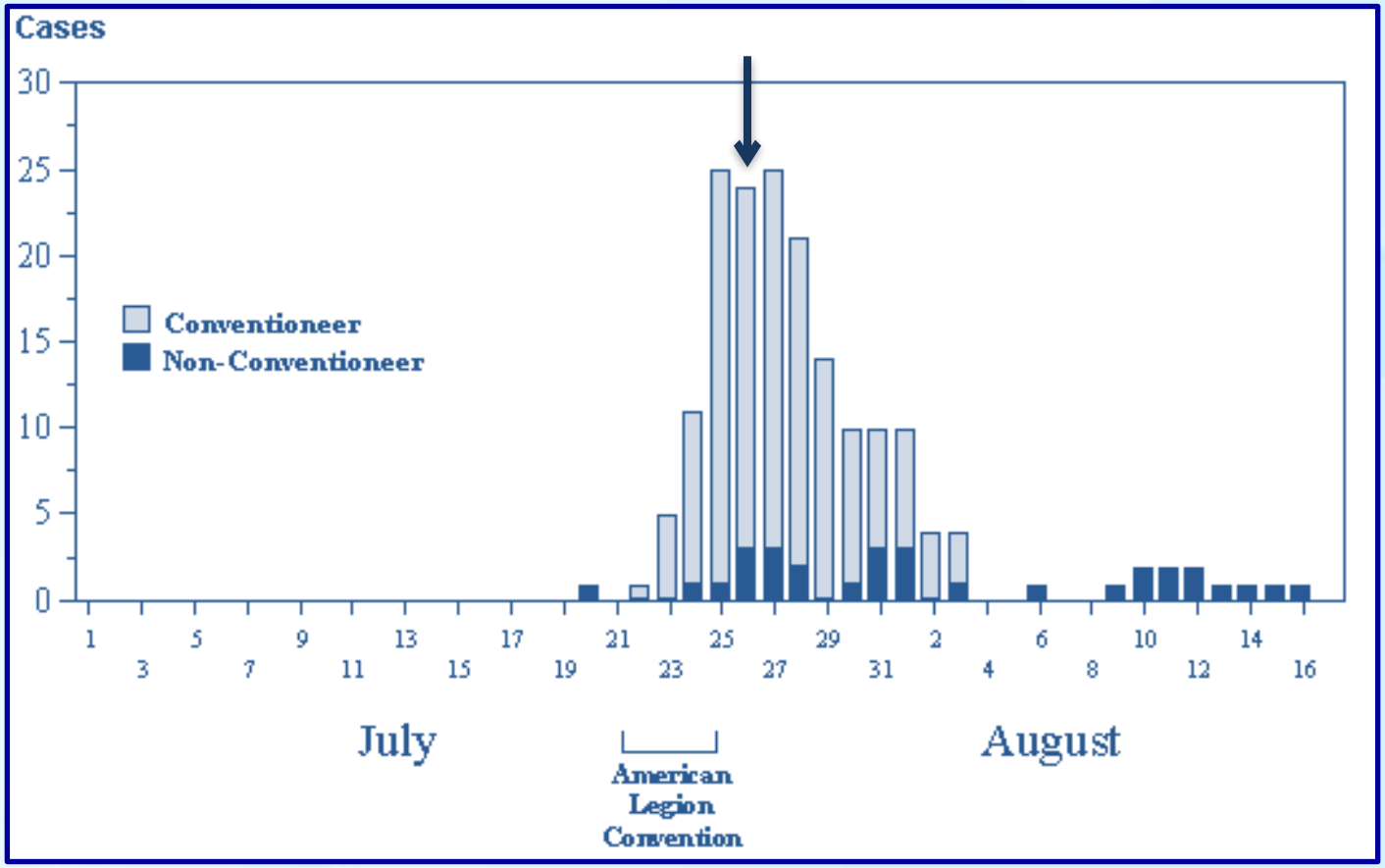


Step 5 — Using descriptive epidemiology

- Describe and orient the data

Fraser DW, Tsai, T, Orenstein W, et al. Legionnaires' disease: description of an epidemic of pneumonia. New Engl J Med 1977;297 1189–97.

Legionnaires' Disease Cases, by Day



Fraser DW, Tsai, T, Orenstein W, et al. Legionnaires' disease: description of an epidemic of pneumonia. New Engl J Med 1977;297:1189–97.

Legionnaires' Disease Attack Rates

	Hotel A			Hotel B			Hotel C		
Age (yrs)	Ill	Total	Percent ill	Ill	Total	Percent ill	Ill	Total	Percent ill
≤39	3	44	6.8	3	116	2.6	6	160	3.7
40–49	9	160	5.6	11	232	4.7	20	392	5.1
50–59	27	320	8.4	25	523	4.8	52	843	6.2
60–69	12	108	11.1	19	207	9.1	31	315	9.8
≥70	11	54	20.4	5	76	6.5	16	130	12.3
Unknown	0	2	0	0	7	0	0	9	0
Total	62	688	9.0	63	1,161	5.4	125	1,849	6.8

Fraser DW, Tsai, T, Orenstein W, et al. Legionnaires' disease: description of an epidemic of pneumonia. New Engl J Med 1977;297: 1189–97.

Outbreak Investigation — Steps 6, 7, and 8



Step 6 — Develop a focused hypothesis

Step 7 — Evaluate the hypothesis for validity

Step 8 — Refine the hypothesis as needed

Fraser DW, Tsai, T, Orenstein W, et al. Legionnaires' disease: description of an epidemic of pneumonia. New Engl J Med 1977;297:1189–97.

Legionnaires' Disease Study Results



Five months after the first cases of Legionnaires' disease occurred, results of the case-control study indicated that spending time in the lobby of Hotel A was a risk factor for illness

Legionnaires' Disease Study Results



In December 1976, a CDC laboratorian successfully located the source bacteria after continuing to test the specimens that were thought to be dead

Outbreak Investigation — Steps 9 and 10



Step 9 — Implement control and prevention measures

- Control and prevent additional cases



Step 10 — Communicate findings

- Determine who needs to know
- Determine how information will be communicated
- Identify why the information needs to be communicated

Fraser DW, Tsai, T, Orenstein W, et al. Legionnaires' disease: description of an epidemic of pneumonia. New Engl J Med 1977;297:1189–97.

Knowledge Check

In 1976, during an American Legion Convention, 11 attendees had died of apparent heart attacks by August 1. Dr. Campbell contacted the Pennsylvania Department of Health after realizing he had treated 3 of those 11 attendees. What is the first step the Pennsylvania Department of Health should have followed?

A. Establish a surveillance system.

B. Alert the convention attendees.

✓ C. Establish the existence of an outbreak.

D. Send an investigation team to the hotel.

Knowledge Check

CDC then launched an investigation. However, no effective communication existed between scientists in the field interviewing patients and those in the laboratory who were testing specimens.

As a first step in stopping this outbreak, what should the team have done to identify persons who were part of the outbreak?

- A. Verify a diagnosis.
- B. Establish a case definition to identify cases.
- C. Communicate findings to the public.
- D. Implement prevention measures.

Knowledge Check

In speculating that the cooling system might be the source of the outbreak, what step was the epidemiologist implementing?

A. Developing a hypothesis.

B. Refining a hypothesis.

C. Evaluating a hypothesis.

D. Verifying a diagnosis.

Knowledge Check

In January 1977, the *Legionella* bacterium was finally identified and isolated and was found to be breeding in the cooling tower of the hotel's air-conditioning system; the bacteria then spread through the building whenever the system was engaged. What should the investigation team do regarding their original hypothesis?

A. Evaluate it.

B. Refine it.

C. Confirm it.

✓ D. Both A and B.

Knowledge Check

The finding from this outbreak investigation lead to development of new regulations worldwide for climate control systems. What step does this illustrate?

A. Communicate the findings.

✓ B. Implement control and prevention measures.

C. Perform descriptive epidemiology.

D. Refine the hypothesis.

Course Summary

During this course, you learned to

- define epidemiology
- describe basic terminology and concepts of epidemiology
- identify types of data sources
- identify basic methods of data collection and interpretation
- describe a public health problem in terms of time, place, and person
- identify the key components of a descriptive epidemiology outbreak investigation

QUESTIONS?

Resources and Additional Reading

- Bogdanich W. Panama releases report on ‘06 poisoning. The New York Times, February 14, 2008.http://www.nytimes.com/2008/02/14/world/americas/14panama.html.
- Centers for Disease Control and Prevention (CDC). CDC helps solve Panama mystery illness. Atlanta, GA: US Department of Health and Human Services, CDC News, October 7, 2006. http://www.cdc.gov/news/2006_10/panama.htm.
- Dean H. Introduction to public health, epidemiology, and surveillance. Atlanta, GA: US Department of Health and Human Services, CDC Science Ambassador Program, July 16, 2012.
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- Sakamoto R, Ohno A, Nakahara T, et al. *Legionella pneumophilia* in rainwater on roads. Emerg Infect Dis 2009;15:1295–7.
- Thacker SB, Birkhead GS. Surveillance [Chapter 3]. In: Gregg, MB, ed. Field epidemiology. 3rd ed. New York, NY: Oxford University Press; 2008.

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