

CIC Study Group

Week 5



HAI Prevention Program

Agenda

Review

- Chapter 10 General Principles of Epidemiology
- Chapter 11 Surveillance
- Chapter 12 Outbreak Investigations

Next week assignments

Chapter 10

General Principles of Epidemiology

Background

Epidemiology is the study of the distribution and determinants of disease and other conditions in human populations and forms the basis of all health-related studies.

- ❖ Provides the background for interventions to reduce transmission of infectious organisms, reduce the number of healthcare-associated infections, and protect healthcare personnel from infection.
- ❖ Primary purpose is to aid in the understanding of the causes of disease by knowing their distribution; determinants in terms of person, place, and time; and natural history.

Key Terms in Infectious Disease Epidemiology

Association: The relationship between a risk factor and an outcome, such as a disease.

Causation: a determination that a particular risk factor results in an outcome, such as a disease.

Cluster: a group of persons with a given disease occurring in the same space and time, but which have not been epidemiologically linked. If an epidemiological link is made, it may become an outbreak.

Endemic: the usual incidence of a given disease within a geographical area during a specified time period.

Epidemic: an excess over the expected incidence of disease within a given geographical area during a specified time period.

Incidence: the number of new cases of a given disease in a given time period.

Outbreak: synonymous with epidemic but a term often preferred when dealing with the public. It may not evoke the same fearful response as the term *epidemic*. In local settings, an outbreak is a group of people with the same disease who are epidemiologically linked.

Pandemic: an epidemic spread over a wide geographical area, across countries or continents.

Prevalence: the number of existent cases of a given disease at a given time.

Risk: the probability or likelihood of an event occurring.

Risk factor: a characteristic, behavior, or experience that increases the probability of developing a negative health status (e.g., disease, infection).

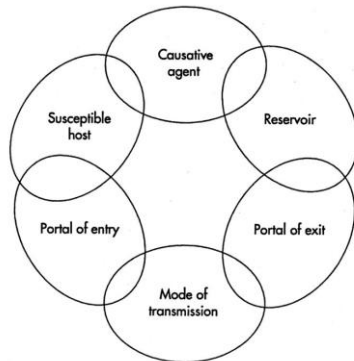
Recall Key Terms From Chapter 21...

Reservoir: a place within which microorganisms thrive and reproduce.

Fomite: inanimate objects or surfaces that can carry and transfer pathogens.

Vector: An organism, often an insect or arthropod, that carries and transmits pathogens from one host to another.

Herd immunity: the resistance of a group to invasion and to spread of an infectious agent, based on the immunity of a high proportion of individual members of the group.



Colonization: the presence of microorganisms in or on a host with growth and multiplication but without tissue invasion or damage.

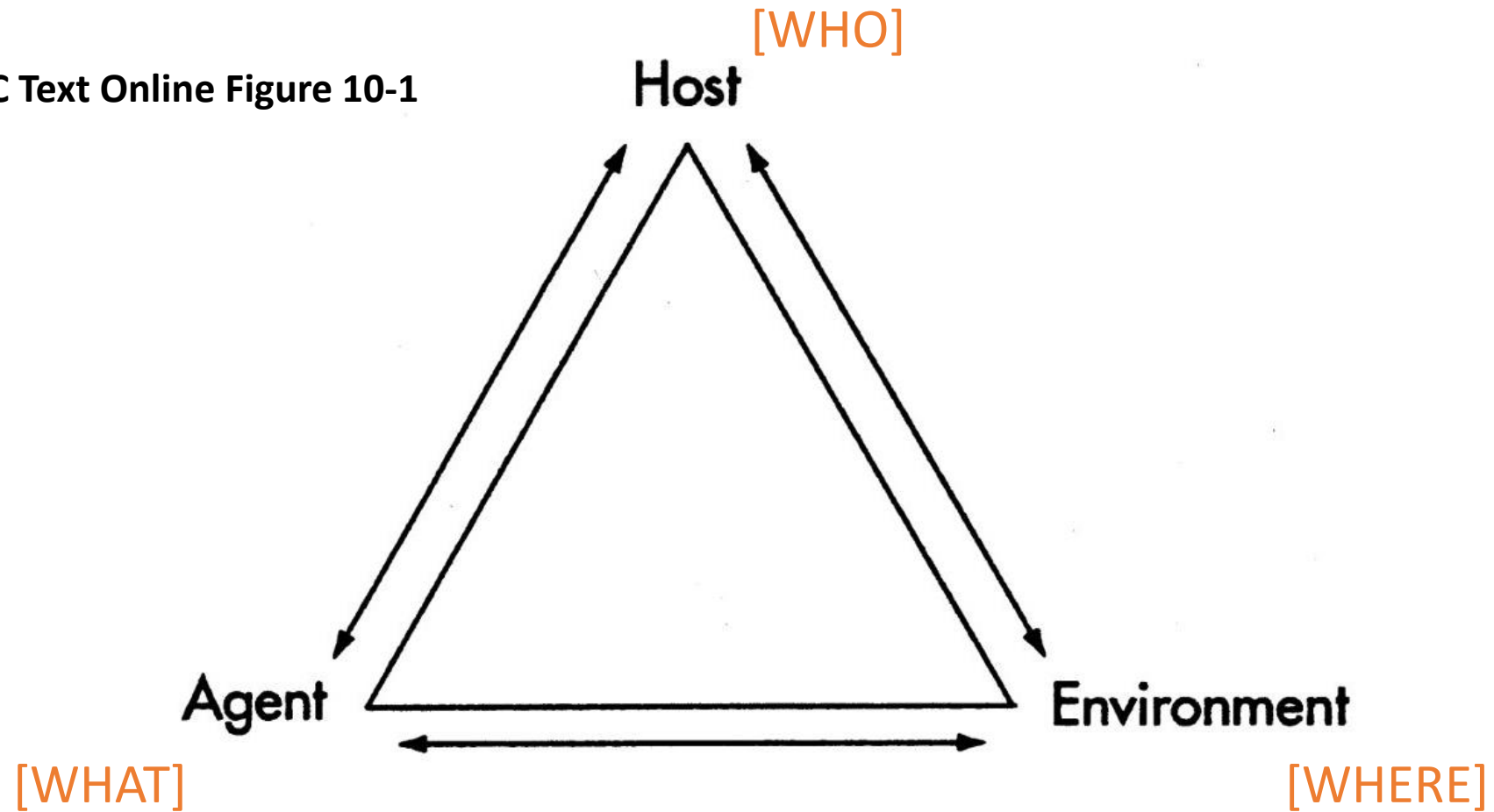
Infection: the entry into and multiplication of an infectious agent in the tissues of the host and tissue damage resulting in apparent or unapparent changes in the host

Community-acquired infection: Infections that patients have upon admission to a healthcare facility, with no association to a recent hospitalization.

Healthcare-associated Infection (HAI): Infections that patients acquire while receiving treatment for other conditions within a healthcare setting.

Epidemiological Models

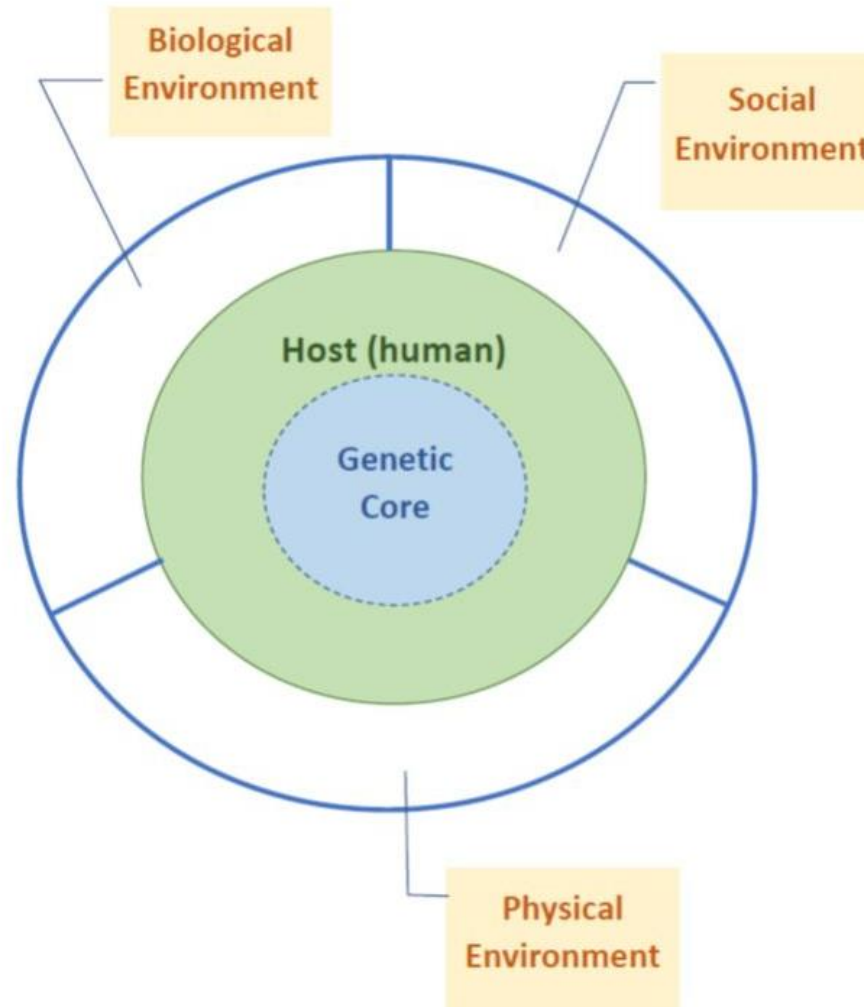
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The Epidemiologic Triangle

Epidemiological Models, Cont.

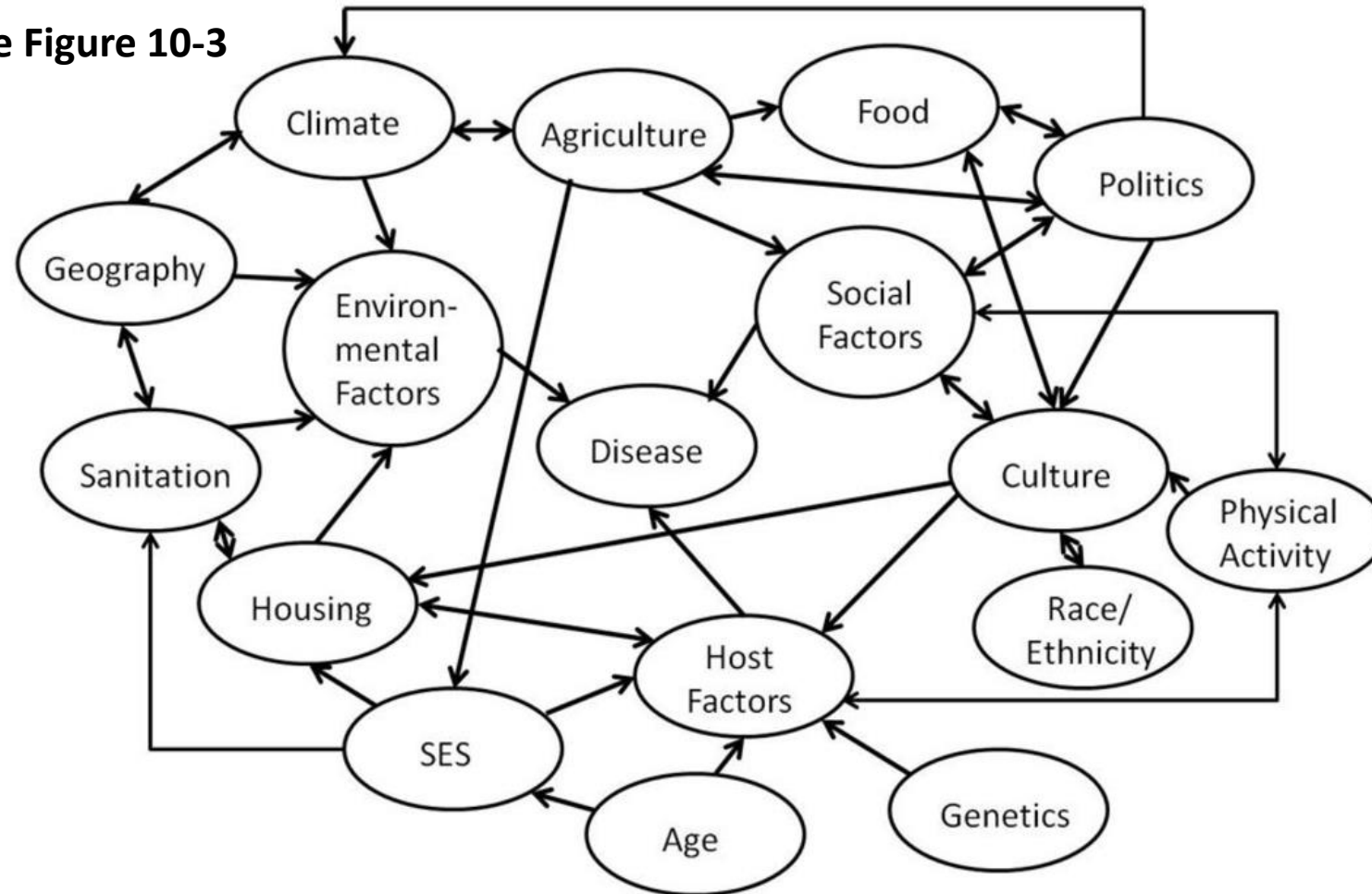
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The Wheel Model

Epidemiological Models, Cont.

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The Web of Causation

Association and Causation

An **association** is the relationship between a risk factor and an outcome, such as a disease.

- ❖ Association occurs if, as one variable changes, there is a related or resultant change in the quantity or quality of another variable.

When a statistical association between a factor and a disease has been demonstrated, it may be of three types:

- ❖ **Artifactual or Spurious**
- ❖ **Indirect or Noncausal**
- ❖ **Causal**

Types of Association

Artifactual or Spurious

Simply occur by chance, referred to as random error. Caused by errors in study design or analysis, leading to the introduction of systematic error or bias.

Indirect or Noncausal

Result from the mixing of effects between the exposure, the disease, and a confounding variable, which may be associated with the exposure and independently affect the outcome of interest.

Causal

When evidence indicates that one factor is clearly shown to increase the probability of the occurrence of a disease. The reduction of a factor decreases the frequency of the disease being studied.

Error, Bias, and Confounding

Error occurs in all studies. It is not possible to control for all random error, but it is possible to limit the level of systematic error or bias in a study.

Bias is a systematic error in study design, recruitment, data collection or analysis that results in a mistaken estimation of the true effect of the exposure and the outcome.

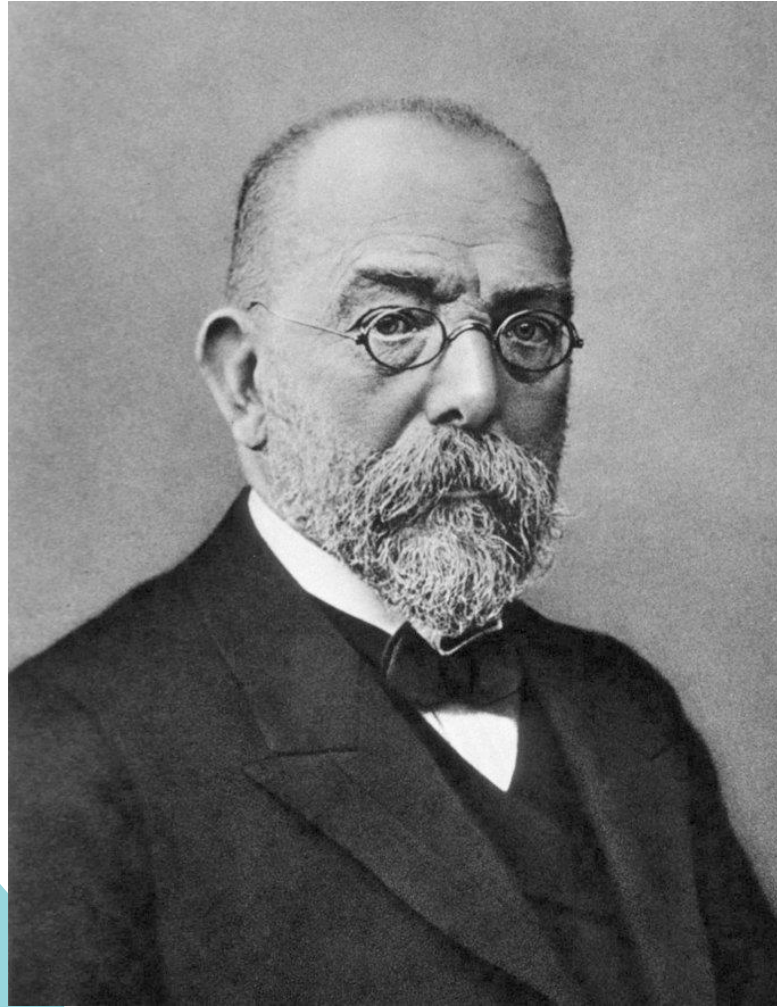
Bias and random error may result in no association being seen where one does exist

Confounding is referred to as the effect a third variable has on the association between an exposure and outcome and must be associated with both disease and outcome.

Failure to control for confounding variables in the study design or analysis may result in artifactual association(s).

Confounding can lead to the assumption that there are differences that do not really exist or to the observation that there is no difference when one truly exists.

Disease Causation



Robert Koch
1843-1910

Father of modern bacteriology

- ❖ Discovered the causative agents of tuberculosis, cholera, and anthrax.

Koch's Postulates

1. The organism must always be found with the disease in accordance with the clinical stage observed.
2. The organism must be grown in pure culture from a diseased host.
3. The same disease must be reproduced when a pure culture of the organism is inoculated into a health susceptible host.
4. The organism must be recovered from the infected host.

Bradford-Hill Criteria for Causality

Bradford-Hill Criteria	Definition
Strength of Association	Incidence of disease should be higher in those who are exposed to the risk factor under consideration than in those who are not exposed; the stronger the association between an exposure and a disease, the more likely the exposure is to be causal.
Consistency	An association should be observed in numerous studies, preferably by different researchers using different research methodologies.
Specificity	An association between one factor and one disease is more likely to be causal. This criterion also refers to the extent to which the occurrence of one factor can be used to predict disease.
Temporality	Exposure to the hypothesized risk factor must precede onset of disease.
Biological Gradient	A dose-response relationship between increased exposure to a risk factor and increased likelihood of disease.
Biologically Plausible	Plausibility in light of current scientific knowledge; lack thereof does not disprove a theoretical association.
Coherence	An association must be in accordance with other facts known about the natural history of the disease.
Experimental Knowledge	Adds considerable weight to evidence supporting causal associations.
Analogy	If similar associations have been shown to be causal, the association is more likely to be causal.

Applying Bradford-Hill Criteria

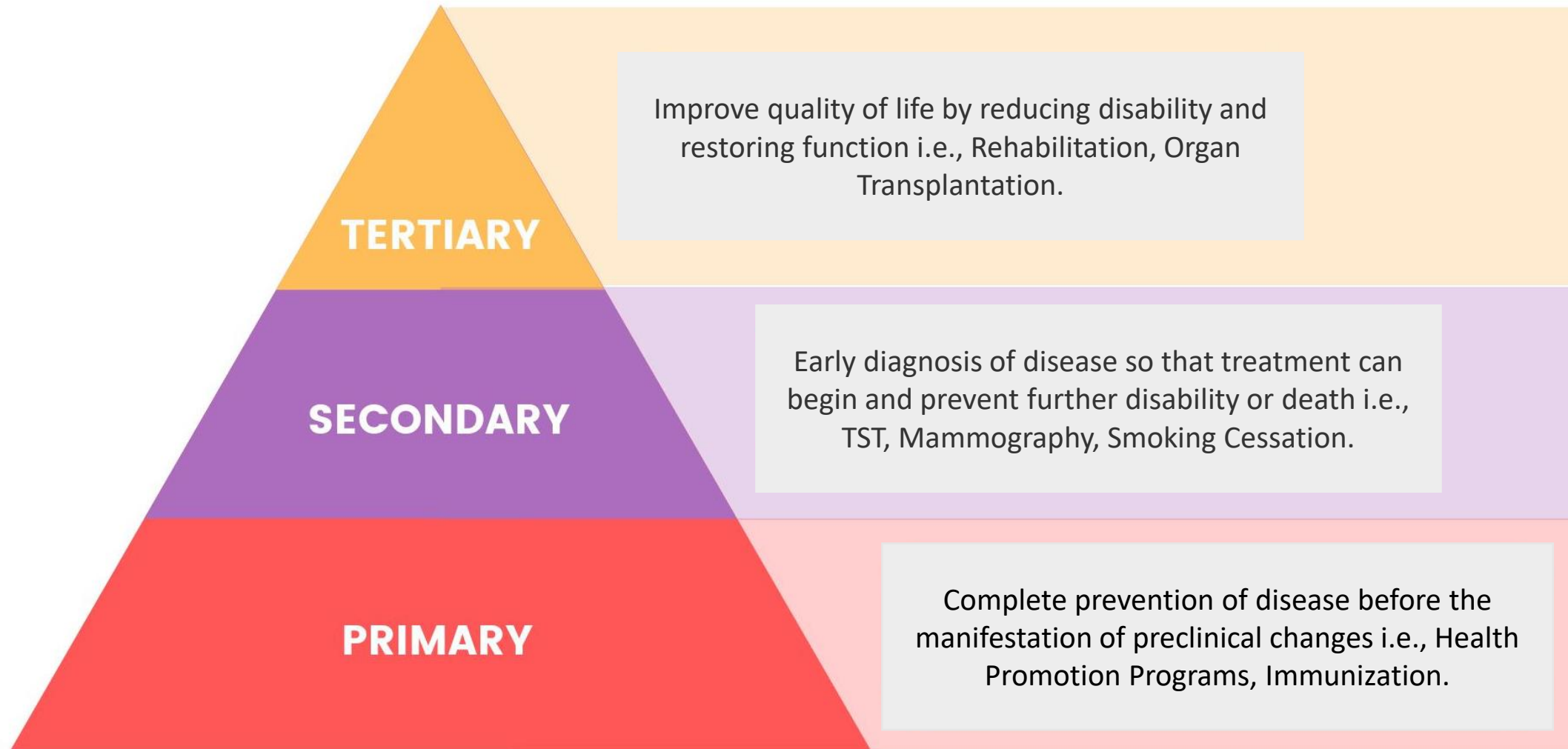
Strength of Association	Disease occurrence (gastroenteritis) among those exposed to the organism (<i>S. sonnei</i>).
Consistency	The association between ingestion of <i>S. sonnei</i> and development of gastroenteritis has been observed consistently in numerous studies by different investigators, although development of disease may not occur in all cases.
Temporality	Exposure to the organism (<i>S. sonnei</i>) precedes development of gastroenteritis and occurs within the correct incubation period.
Biological Gradient	Larger doses of <i>S. sonnei</i> are more likely to result in disease.
Biologically Plausible	<i>S. sonnei</i> is a biologically plausible cause of gastroenteritis, based on current scientific knowledge of its toxin production.
Coherence	Disease caused by <i>S. sonnei</i> is coherent with other facts known about gastroenteritis.
Analogy	Experiments have shown that <i>S. sonnei</i> causes gastroenteritis and that other species of <i>Shigella</i> cause similar disease.



Shigella sonnei

*Remember, these criteria are equally applicable to infectious and noninfectious diseases and are not to be used as a checklist, as the criteria do not fit all diseases. Applying the criteria for causality is not as straightforward when disease etiology is unclear.

Categories of Prevention



Recall from Chapter 21...

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Break the Chain of Infection

BREAK THE CHAIN!

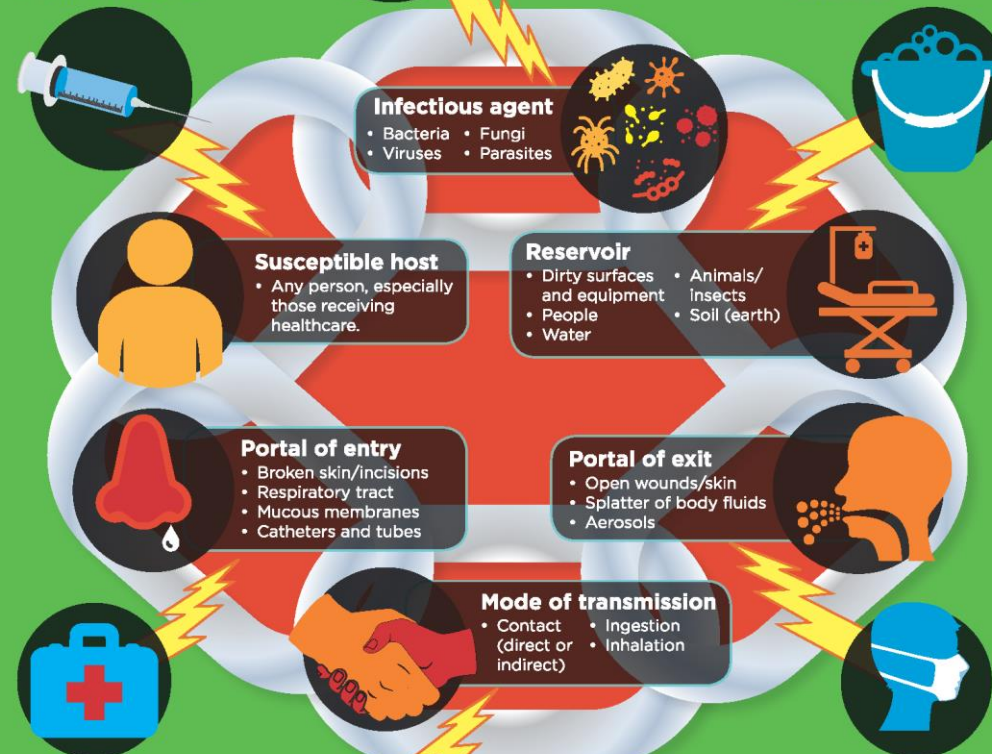
- ✓ Immunizations
- ✓ Treatment of underlying disease
- ✓ Health insurance
- ✓ Patient education

BREAK THE CHAIN!

- ✓ Diagnosis and treatment
- ✓ Antimicrobial stewardship

BREAK THE CHAIN!

- ✓ Cleaning, disinfection, sterilization
- ✓ Infection prevention policies
- ✓ Pest control



BREAK THE CHAIN!

- ✓ Hand hygiene
- ✓ Personal protective equipment
- ✓ Personal hygiene
- ✓ First aid
- ✓ Removal of catheters and tubes

BREAK THE CHAIN!

- ✓ Hand hygiene
- ✓ Personal protective equipment
- ✓ Food safety
- ✓ Cleaning, disinfection, sterilization
- ✓ Isolation

BREAK THE CHAIN!

- ✓ Hand hygiene
- ✓ Personal protective equipment
- ✓ Control of aerosols and splatter
- ✓ Respiratory etiquette
- ✓ Waste disposal

Epidemiological Study Design

Prospective [Cohort Study]

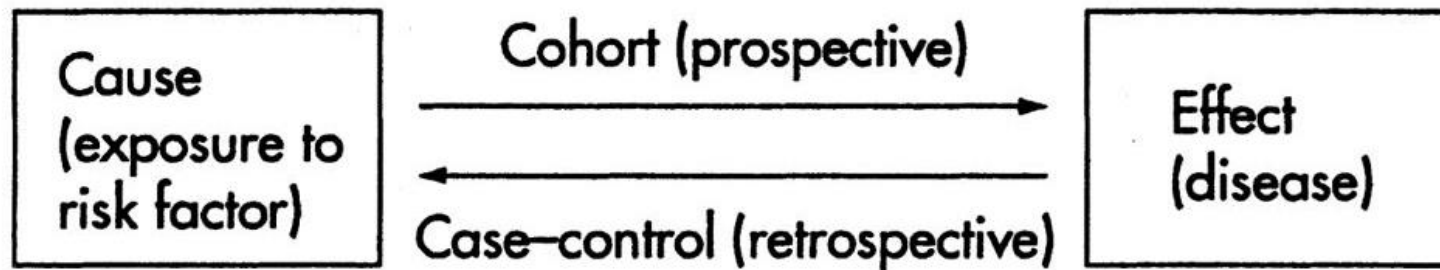
Subjects with known exposure status for the risk factor(s) of interest are followed over time to determine which subjects develop disease.

- ❖ **Advantages:** Subject to fewer bias issues, yield incidence rates and associations between risk factors and disease, tend to be used when controversial retrospective findings need to be verified.
- ❖ **Disadvantages:** More expensive due to increased time requirement, lengthier follow-up periods causing loss of sample size over time.

Retrospective [Case-Control Study]

Identifies subjects with the disease and measures their degree of exposure to past risk factor(s) of interest.

- ❖ **Advantages:** Use already available data, requires relatively small number of subjects, takes less time and tends to be less expensive, suitable for studying rare disease states.
- ❖ **Disadvantages:** Dependent on completeness of subject records, difficult selecting appropriate control group, subject to recall bias.



Concept Check

An acute-care facility experiences an outbreak of *Serratia marcescens* bloodstream infections. After the outbreak is under control and no new cases are being reported, the Infection Preventionist (IP) wants to find the source of the outbreak. The most appropriate epidemiology study design to use is:

- A. Case-control study
- B. Retrospective cohort study
- C. Prospective cohort study
- D. Cross-sectional study

Concept Check

Which of the following is not an advantage of a Retrospective study?

- A. Takes less time
- B. Requires fewer subjects
- ☒ C. Data are more accurate
- D. Considered less expensive

Concept Check

A major difference between a prospective and a retrospective study is that the prospective study:

- A. Requires a relatively small number of subjects.
- B. Is usually used for testing initial hypotheses.
- C. Is usually less expensive.
- ☒ D. May require a long follow-up period.

Chapter 11

Surveillance

Background

Surveillance is the systematic and ongoing monitoring of healthcare-associated infections that occur within healthcare facilities.

- ❖ Surveillance activities should be based upon a facility driven risk assessment for infection and other adverse events, implement risk-reduction strategies and measures, and monitor the effectiveness of interventions.
- ❖ Surveillance plays a critical role in identifying outbreaks, pandemics, emerging infectious diseases, multidrug-resistant organisms, and bioterrorist events so that infection prevention measures can be instituted.

Key Terms in Infectious Disease Surveillance

Baseline: The number or value used as the basis for comparison.

Case: An instance of a particular disease, injury, or other health condition that meets selected criteria.

Case definition: A set of uniformly applied criteria for determining whether a person should be identified as having a particular disease, injury, or other health condition.

Contact tracing or contact investigation: The practice of identifying and monitoring individuals who may have had contact with an infectious person as a means of controlling the spread of a communicable disease.

Denominator: The lower portion of a fraction used to calculate a rate or ratio.

Distribution: The frequency and pattern of an event in a population.

Outcome: The result of care or performance activities

Rate: An expression of the frequency with which an event occurs in a defined population per unit of time. In healthcare surveillance, it is often used more casually to refer to proportions that are not truly rates.

Ratio: The value obtained by dividing one quantity in the numerator by another in the denominator.

Repeatability: The variability of a measurement.

Reproducibility: Measures the degree of agreement of an experiment or study performed by different individuals in different locations and with different instruments.

Syndromic Surveillance: Collecting and analyzing nontraditional data, such as rates of influenza-like illness or number of emergency department patients, for early detection of an infectious disease disaster.

Validity: The degree to which a measurement, test, study, or other data collection method measures or detects what it is intended to measure.

Surveillance Methodologies

Facility-Wide Surveillance

- ❖ Also referred to as total, comprehensive, or house-wide surveillance; all patient care areas are monitored for healthcare-associated infections (HAIs).

Targeted Surveillance

- ❖ Focuses on high-risk, high-volume procedures, healthcare-associated infections (HAI)s, preventable adverse outcomes, and state or local mandatory reporting.

Centralized Surveillance

- ❖ Data collection, analysis, and reporting are centralized to a single department often lead by facility Infection Preventionists, Data Analysts, or Epidemiologists.

Measurement of Surveillance Activities

Outcome Measures	Process Measures
Injury reporting surveillance for healthcare personnel complying with safe injection and medication handling practices	Sharps and Needlestick injury rate in healthcare personnel
Tuberculosis screening, testing, and evaluation of at-risk healthcare personnel	QuantiFERON-TB Gold or IGRA conversion rates in healthcare personnel
Healthcare personnel compliance with hand hygiene procedure	Hand Hygiene compliance rate by unit
Healthcare personnel compliance with central line insertion practices, maintenance, and removal	CLABSI rate by unit
Healthcare personnel compliance with urinary catheter insertion practices, maintenance, and removal.	CAUTI rate by unit

National Healthcare Safety Network (NHSN)

NHSN provides healthcare facilities, health departments, states, and regions with data needed to identify areas of improvement, measure progress of prevention efforts, and ultimately eliminate healthcare-associated infections (HAIs).

The National Health and Safety Network is composed of seven components: Biovigilance, Dialysis, Healthcare Personnel Safety (HPS), Long-Term Care Facility, Neonatal, Outpatient, and Patient Safety.

- ❖ Central Line-associated Blood Stream Infection (CLABSI)
- ❖ Catheter-associated Urinary Tract Infection (CAUTI)
- ❖ Surgical Site Infection (SSI)
- ❖ Ventilator-associated event (VAE)
- ❖ Hospital-onset *Clostridioides difficile* (HO CDI)
- ❖ Hospital-onset Methicillin-resistant *Staphylococcus aureus* (HO MRSA)

National Healthcare Safety Network (NHSN)

$$SIR = \frac{\text{Observed (O) HAIs}}{\text{Predicted (P) HAIs}}$$

The Standardized Infection Ratio (SIR) is the primary summary measure used by the National Healthcare Safety Network (NHSN) to track healthcare-associated infections (HAIs).

SIR < 1	SIR > 1
Fewer infections than predicted given the baseline data.	More infections than predicted given the baseline data.
Infections have been prevented since the baseline period.	Infections have increased since the baseline period.
1 minus the SIR = percent reduction If the SIR for CAUTI in a post-surgical stepdown unit is 0.45, there was a 55% reduction in infection from the baseline period.	SIR minus 1 = percent increase If the SIR for CLABSI in a dialysis unit is 1.25, there was a 25% increase in infection from the baseline period.

Mandatory and Public Reporting

Reportable Diseases/Conditions in Florida

Laboratory List (Health Care Practitioner Requirements Differ)

Per Rule 64D-3.029, Florida Administrative Code, promulgated August 18, 2021



Florida Department of Health
(Department)

Did you know that you are required* to report your local county health department (CHD)?

Please visit www.FloridaHealth.gov/DiseaseReporting for more information. If you need a result, contact your CHD epidemiology program (www.FloridaHealth.gov/Contact). To reach your CHD, please call the Department's Bureau of Epidemiology at 850-412-1313.

! Detection in one or more specimens of etiological agents of a disease or condition not listed that is of urgent public health significance; agents suspected to be the cause of a cluster or outbreak

Arboviruses

! Arboviruses not otherwise listed, including but not limited to: Flaviviridae, Togaviridae (e.g., Western equine encephalitis virus), and Bunyaviridae (e.g., Heartland virus) [icon]

• California serogroup viruses (e.g., Jamestown Canyon, Keystone, Lacrosse) [icon]

• Chikungunya virus [icon]

! Dengue virus [icon]

• Eastern equine encephalitis virus [icon]

Reportable Diseases/Conditions in Florida

Practitioner List (Laboratory Requirements Differ)

Per Rule 64D-3.029, Florida Administrative Code, promulgated August 18, 2021



Florida Department of Health

Did you know that you are required* to report certain diseases to your local county health department?

- ! Report immediately 24/7 by phone upon initial suspicion or laboratory test order
- ☎ Report immediately 24/7 by phone
- Report next business day
- + Other reporting timeframe

! Outbreaks of any disease, any case, cluster of cases, or exposure to an infectious or non-infectious disease, condition, or agent found in the general community or any defined setting (e.g., hospital, school, other institution) not listed that is of urgent public health significance

+ Acquired immune deficiency syndrome (AIDS)

☎ Amebic encephalitis

! Anthrax

• Arsenic poisoning

! Arboviral diseases not otherwise listed

• Babesiosis

! Botulism, foodborne, wound, and unspecified

• Botulism, infant

! Brucellosis

• California serogroup virus disease

• Campylobacteriosis

• Granuloma inguinale

! Haemophilus influenzae invasive disease in children <5 years old

• Hansen's disease (leprosy)

☎ Hantavirus infection

☎ Hemolytic uremic syndrome (HUS)

☎ Hepatitis A

• Hepatitis B, C, D, E, and G

• Hepatitis B surface antigen in pregnant women and children <2 years old

☎ Herpes B virus, possible exposure

• Herpes simplex virus (HSV) in infants <60 days old with disseminated infection and liver involvement; encephalitis; and infections limited to skin, eyes, and mouth; anogenital HSV in children <12 years old

+ Human immunodeficiency virus (HIV) infection

• HIV-exposed infants <18 months old born to an HIV-infected woman

• Pesticide-related illness and injury, acute

! Plague

! Poliomyelitis

• Psittacosis (ornithosis)

• Q Fever

☎ Rabies, animal or human

! Rabies, possible exposure

! Ricin toxin poisoning

• Rocky Mountain spotted fever and other spotted fever rickettsioses

! Rubella

• St. Louis encephalitis

• Salmonellosis

• Saxitoxin poisoning (paralytic shellfish poisoning)

! Severe acute respiratory disease syndrome associated with coronavirus infection

• Shigellosis

Concept Check

An Infection Prevention team has completed an investigation of an increase in post-discharge Surgical Site Infections (SSIs) following appendix procedures. They identified some corrective measures that will require monitoring. Which of the following actions should the Infection Prevention team take?

- A. Monitor the cleaning and disinfection of the operating rooms.
- B. Ensure the effectiveness of the operating room ventilation system.
- ☒ C. Revise the facility's surveillance plan.
- D. Ensure that surgical equipment is adequately cleaned, disinfected, and sterilized.

Concept Check

The Standardized Infection Ratio (SIR) for Central Line Associated Blood Stream Infections (CLABSI) in an Intensive Care Unit is 0.8. Which of the following is correct?

- A. There were 80% more CLABSIs in the ICU than the national benchmark.
- B. There were 80% less CLABSIs in the ICU than the national benchmark.
- C. There were more CLABSIs in the ICU than previously predicted.
- D. There were fewer CLABSIs in the ICU than previously predicted.

Concept Check

Which of the following is an example of surveillance on a process measure?

- A. Healthcare personnel compliance rate with urinary catheter insertion in the emergency department.
- ☒ B. The rate of hand hygiene compliance in the emergency department.
- C. The number of healthcare personnel who successfully completed sharp object injury education in the emergency department.
- D. The rate of healthcare personnel who at-risk for Tuberculosis (TB) exposure in the emergency department.

Chapter 12

Outbreak Investigations

Background

Disease **outbreaks** are adverse events which can occur in any healthcare setting and pose a threat to patient safety and lives.

- ❖ Outbreaks can be due to lapses in infection prevention or clinical practices, known or unknown infectious patients or visitors, contaminated or defective products and devices, and colonized or infected healthcare personnel.
- ❖ Regardless of scope, an investigation of a potential outbreak involves predictable epidemiological elements.

Components of an Outbreak Investigation

Initial	Follow-up
❖ Confirm presence of an outbreak ❖ Identify investigation team and resources ❖ Verify the diagnosis ❖ Establish a preliminary case definition ❖ Alert administration ❖ Perform literature review ❖ Develop methodology for case finding ❖ Prepare initial line list ❖ Observe and review potentially implicated patient care activities ❖ Implement initial control measures	❖ Continue case finding and surveillance ❖ Regularly review control measures ❖ Maintain surveillance activities

The Epidemic Curve

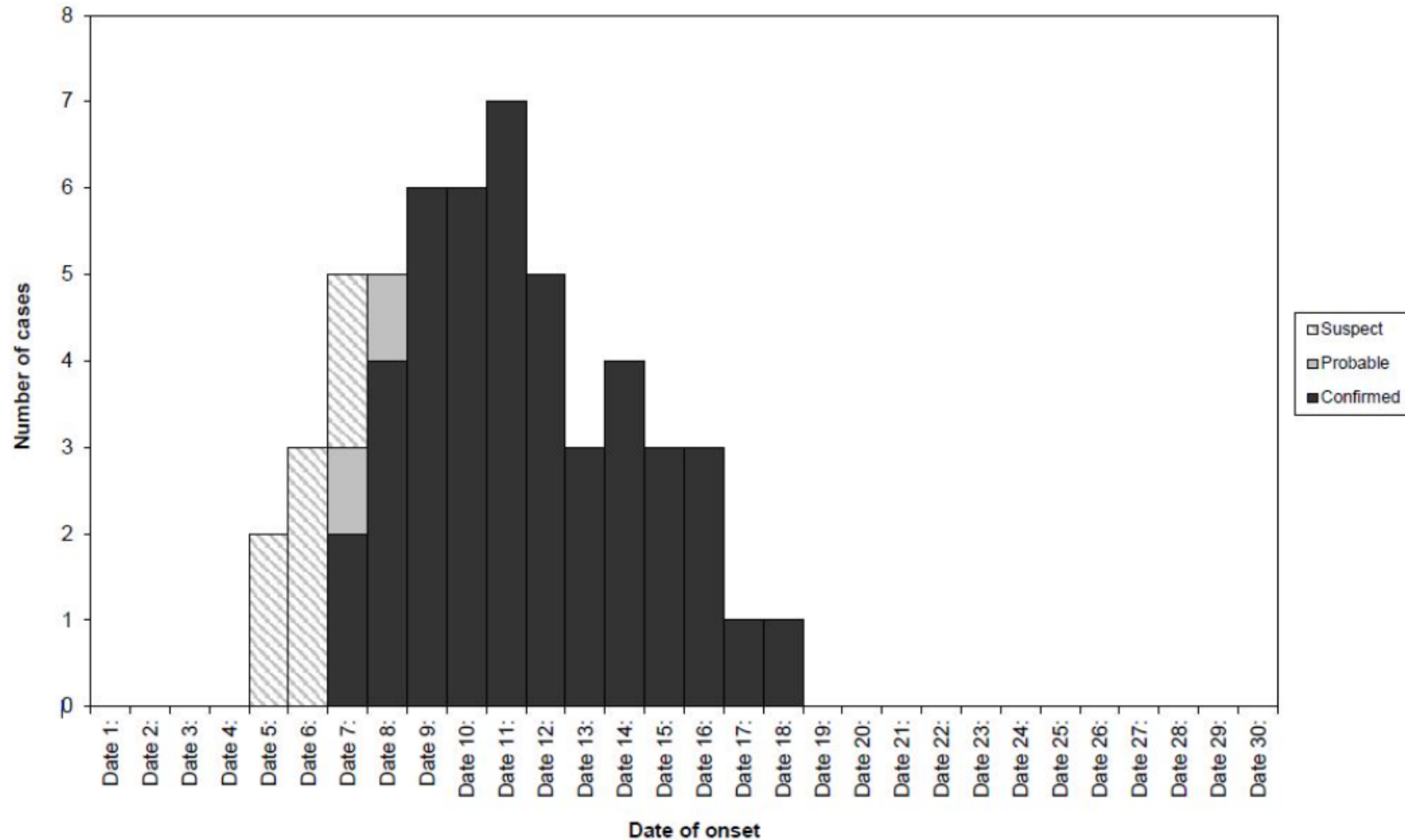
An **epidemic curve** is a graph in which the cases of a disease that occurred during an outbreak are plotted according to the time of onset of illness.

The epidemic curve is used to:

- ❖ Determine whether source of infection is common (point source) or propagated.
- ❖ Establish if the pathogen in question has a short or long incubation period.
- ❖ Ascertain if the outbreak is increasing or waning.

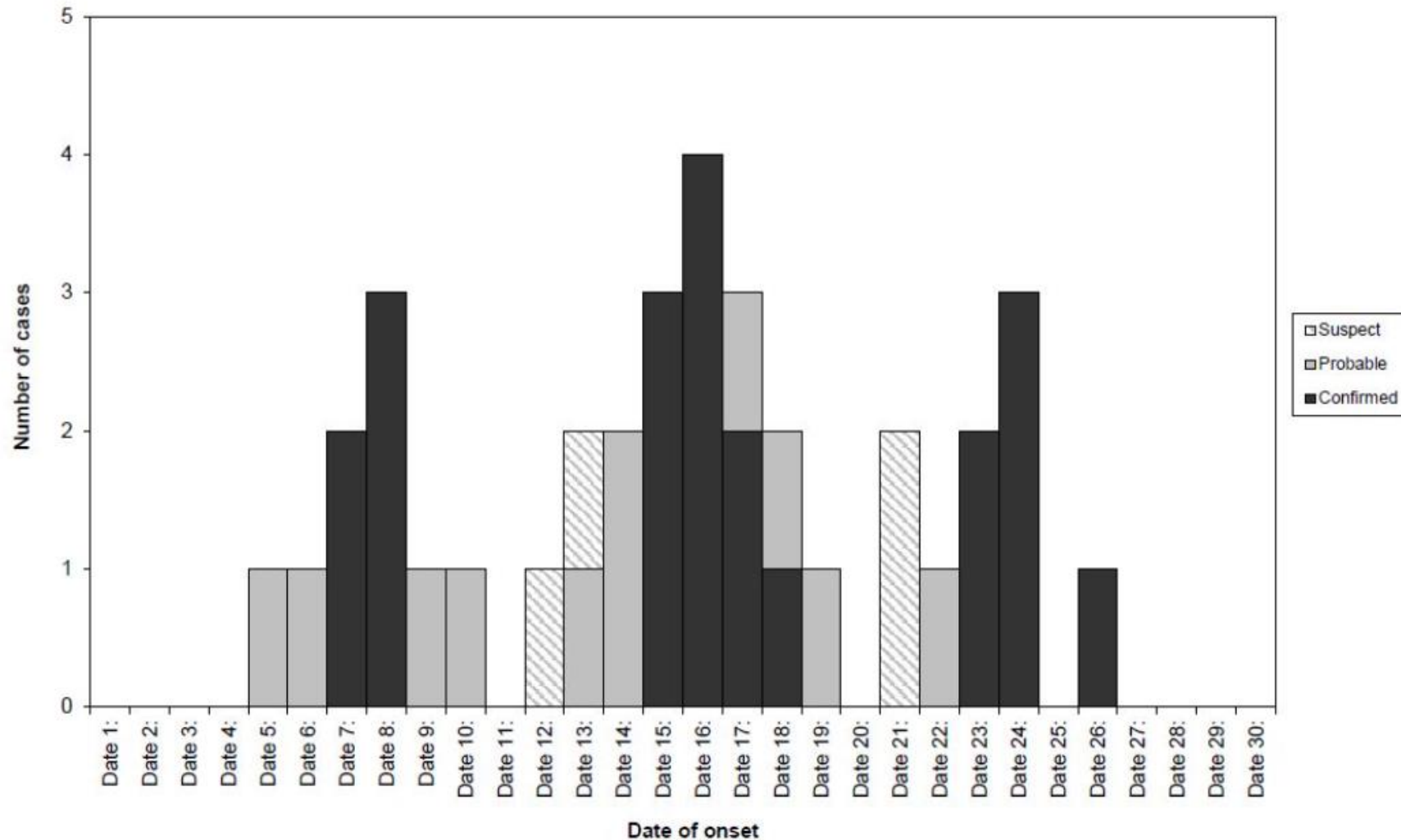
Point Source Outbreak

Figure: Epi Curve Template for Respiratory Illness Outbreak



Propagated Source Outbreak

Figure: Epi Curve Template for Respiratory Illness Outbreak



Concept Check

An outbreak of Norovirus in a long-term care facility (LTCF) would most likely have an epidemiological curve that:

- A. Indicates a common source of infection.
- ☒ B. Indicates a propagated source of infection.
- C. Indicates a point source of infection.
- D. Indicates a common vehicle of infection.

Week 6 Assignments

Action Items

Assigned chapter readings:

- Chapter 13 Use of Statistics in Infection Prevention
- Chapter 14 Process Control Charts
- Chapter 15 Risk-Adjusted Comparisons