Surveillance and Outbreak invetigation

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Learning Objectives:

- Describe the purposes of surveillance system
- Define different types of surveillance
- Understand steps in outbreak investigation using a framework

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Introduction to Surveillance

- **Definition:**
  - Surveillance is the ongoing, systematic collection, analysis, interpretation, and dissemination of health-related (already available) data for planning, implementing, and evaluating public health practice.

Information for Action

Introduction to Surveillance

- Surveillance provides the information for descriptive epidemiology, which is
  - Person (age, sex, description)
  - Place (where)
  - Time (dates, hours, days, months, years)

Most countries have regulations for mandatory reporting of a list of diseases (notifiable diseases):

- Polio
- Measles
- Tetanus
- Diphtheria
- TB
- Hepatitis
- Meningitis
- Leprosy

Purposes of surveillance:

Surveillance is the backbone of public health

- **Detect outbreaks** early to initiate a response
- **Monitoring Endemic Diseases**: Routine observation of diseases with predictable patterns.
- **Monitor trends of communicable diseases and Forecasting changes**
- **Evaluate the effectiveness of interventions** (e.g., vaccination, hygiene practices).
- **Guide allocation of resources** (basic for costing studies).
- **Global Health Security**: Contributing to preparedness and response in international outbreaks (e.g., COVID-19).

"I spy with my little eye..."

Epidemiological Intelligence!

Example: Surveillance of influenza cases during seasonal outbreaks to identify peaks, forecast outbreaks and plan vaccination campaigns.

Key Components of Surveillance

Data Collection:

- Sources: Hospitals, clinics, laboratories, community health workers, and population surveys.
- Data Required: Case counts, demographic details (age, gender), location, symptoms, outcomes, and vaccination status.
- Example: Collection of COVID-19 cases from hospitals worldwide

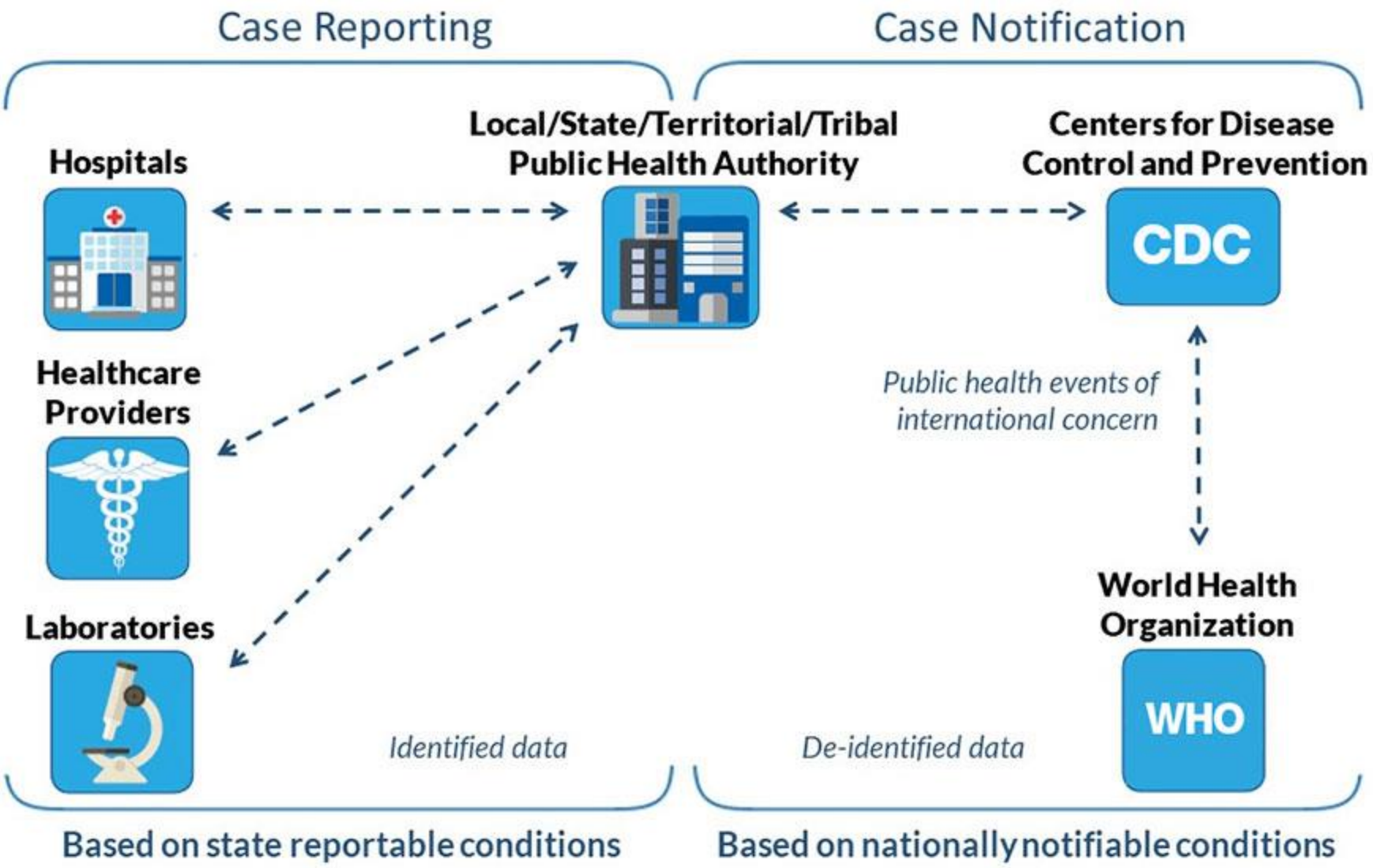
Data Analysis:

- Identify patterns: Time trends, geographic spread, and at risk populations.
- Detect unusual spikes that indicate potential outbreaks.
- Tools: Statistical software, graphs, and epidemiological models.
- Example: Analysis of malaria trends to observe seasonal peaks.

Dissemination:

- Sharing analyzed data with stakeholders like health authorities, governments, and the public.
- Formats: Reports, announcement, and press releases.
- Example: Weekly WHO reports on global disease surveillance.

Case Surveillance



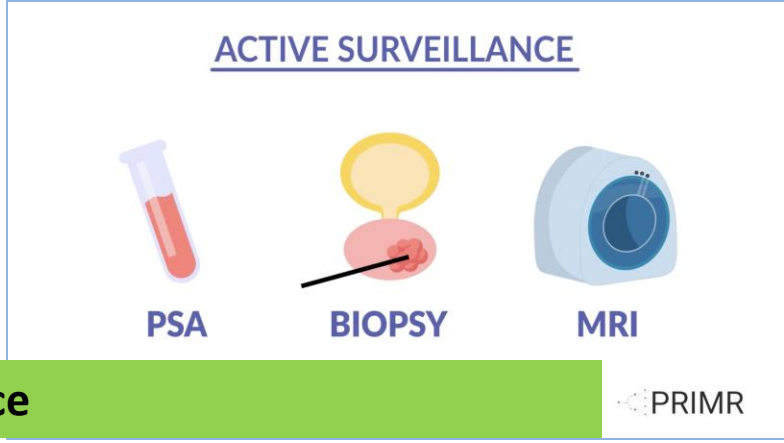
Types of surveillance

1. Passive Surveillance

- Routine reporting of cases from healthcare providers to public health authorities.
- Physicians, clinics, laboratories, and hospitals that are required to report disease are given the appropriate forms and instructions, with the expectation that they will record all cases of reportable disease that come to their attention.
- Most public health surveillance systems are passive
- Example: Tracking tuberculosis cases through mandatory hospital notifications.

Advantages	**Disadvantages:**
Simple	Under-reporting
cost-effective	incomplete data
Suitable for routine data collection	Delays in reporting

Types of surveillance



2. Active Surveillance

PRIMR

- Proactively seeking out cases through direct contact, field visits, or surveys.
- When aim is for eradication or elimination (Smallpox).
- Negative reporting is also required (report of no cases).
- Requires periodic (usually weekly) telephone calls, electronic contact or personal visits to the reporting individuals and institutions to obtain the required data.
- **Example**: Door-to-door polio case identification campaigns (Ebola outbreak monitoring in West Africa, where field teams actively sought and isolated cases)

Advantages:	Disadvantages:
Accurate (higher quality data) and timely.	Expensive
Identifies unreported or missed cases.	resource-intensive

Types of surveillance

3. Sentinel Surveillance

- Monitoring specific sites ("sentinel sites“-e.g. GP Clinics) that represent a larger population.
- Provides high-quality, detailed data for specific diseases.
- **Example**: HIV surveillance in sentinel antenatal clinics in sub-Saharan Africa to estimate population infection rates.

Types of surveillance

4. Syndromic Surveillance

- Monitoring symptoms and health indicators (cases that meet a clinical case definition for disease under surveillance) before diagnosis is confirmed (without lab. confirmation)
- Helps in Rapid/Early detection of unusual health events.
- **Example:**

- Monitoring acute fever/rash to monitor measles or rubella.
- STDs
- Using emergency room visits to detect potential bioterrorism events in the 2001 U.S. anthrax attacks.

Investigation of outbreaks
Why Investigate Outbreaks?

1. **Limit Many Outbreaks**

   Early investigation helps stop the spread of current and potential future outbreaks.

2. **Small Outbreaks May Uncover Widespread Problems**

   A localized outbreak can reveal larger systemic issues (e.g., contaminated water or unsafe practices).

3. **Productive Research Opportunities**

   Outbreaks provide real-world data for studying diseases, dose responses, severity,.)

4. **First Clue in Discovery of New Diseases or Organisms**

   Outbreak investigations often lead to identifying **new diseases** or previously unknown infectious agents.

   Example: HIV, SARS, or COVID-19 were initially identified through outbreak analysis.

5. **Understanding the Disease and Organisms**

   Investigations provide insights into:

   1. **Incubation period**
   2. **Modes of transmission**
   3. **Natural history of the disease**

Investigation of outbreaks

Ten principles of investigation

Solving mystery action

1. **Determine the existence of an outbreak**
2. **Confirm the diagnosis**
3. **Define and identify cases**
4. **Collect information**
5. **Describe and Analyze data**
6. **Develop a hypothesis**
7. **Test the hypothesis**
8. **Implement control and prevention measures**
9. **Communicate findings**
10. **Prepare a report**

1. Determine the existence of an outbreak

- Verify whether the observed number of cases exceeds what is expected (using surveillance data and comparison to historical trends considering factors like seasonal variations).

In July 2020, a sudden increase in food poisoning cases was reported in Amman, Jordan, with over 800 individuals affected and one child tragically dying, prompting further investigation into the outbreak.

https://www.theguardian.com/world/2020/jul/30/more-than-800-hospitalised-in-jordan-food-poisoning-outbreak

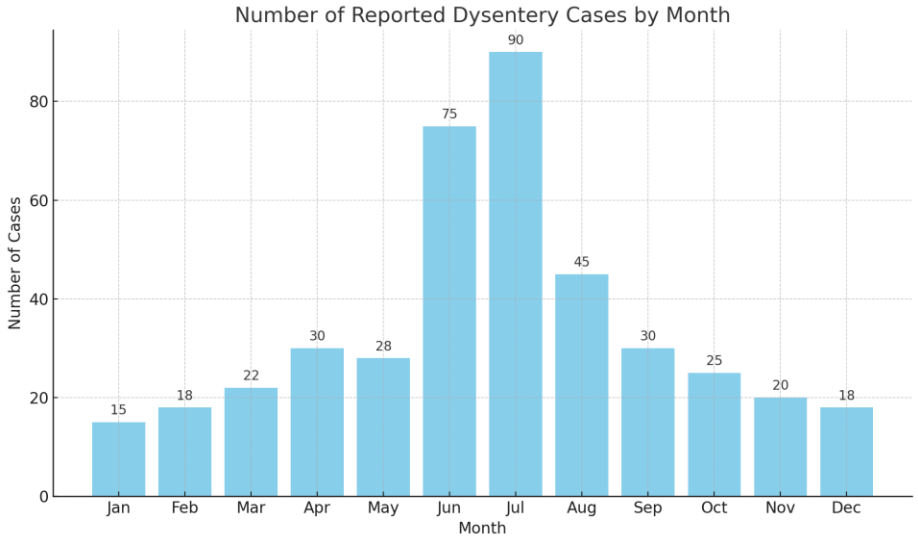
Remember:

Compare the Observed with the Expected

- It is important to verify that the cases are due to the same disease, as symptoms may overlap even when patients have different illnesses. Increases in case numbers can sometimes be attributed to factors other than a true outbreak, including:
- Changes in case definitions,
- Adjustments to the surveillance system,
- Seasonal trends,
- Improvements in laboratory testing procedures,
- Increased public awareness, or
- Laboratory errors.

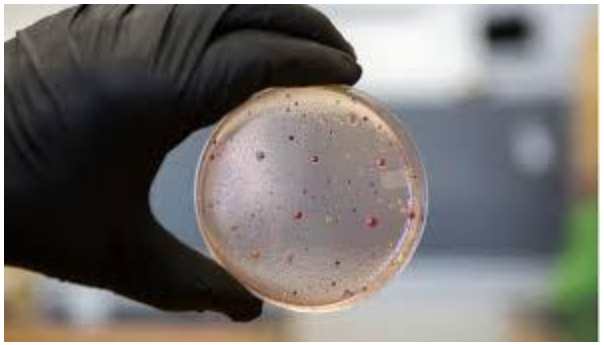
A true outbreak cannot be confirmed or ruled out until all these possibilities have been carefully considered and investigated.

Suspicions but not certain, we need historic data to rule out seasonal variation



2. Confirm the diagnosis

- Confirm the correct diagnosed through clinical assessment and laboratory testing. This step ensures that the outbreak is not due to misdiagnosis or laboratory error.
- Samples not only just those affected (blood, stool, vomit..etc), but also possible sources (such as food or water) or environment (kitchen surfaces and utensils).
- Example: during the 2019 Campylobacter outbreak in Norway, laboratory tests confirmed the presence of Campylobacter bacteria in patients, validating the clinical diagnosis and confirming the outbreak's etiology.



3. Define and identify cases

- Establish a Case Definition: A standard set of criteria for deciding whether a person should be classified as having the disease under study.
- Includes **four components:**

– Information about the event,

– Characteristics about the people who are affected,

– Information about the location or place,

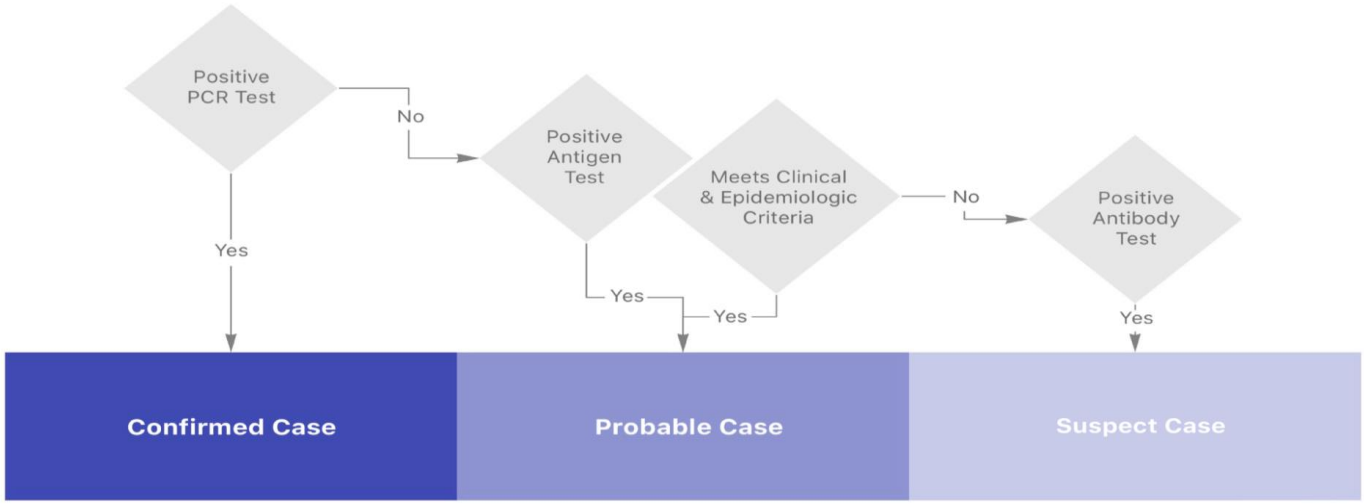
– A specification of time during which the outbreak occurred.

- Example 1: A group of students studying at university X, who ate at the same cafeteria experienced diarrheal illness between the months of January and February.
- Example 2: In the 2015 Legionnaires' disease outbreak in New York City, the case definition included individuals with pneumonia onset after a specific date, residing or working in a particular area, and with laboratory confirmation of Legionella bacteria.

3. Define and identify cases

- An ideal case definition includes most true cases while minimizing false positives (people without the disease who meet the definition).
- Due to diagnostic uncertainty, Cases are often classified as:
- **Confirmed:** A case usually must have laboratory verification
- **Probable:** Acase has typical clinical features of the disease without laboratory confirmation
- **Possible:** A case has fewer of the typical clinical features, epidemiological link not confirmed.

Classifying a COVID-19 case using the CSTE definition



Source: The COVID Tracking Project

4. Collect information:

- "Line listing"

It is a table that helps identify number of diagnosed cases and information relevant to disease outbreak. The columns represent specific patient information and the rows represent each case.

Information would you like to include in the line list:

- Identifying information: name, address, contact information.

- Demographic information: Age, sex, date of birth, current status(dead or alive)
- Clinical information: date of report, date of onset of symptoms, presenting symptoms, diagnosis, laboratory findings.

- Relevant risk factor information: last meal eaten (what and where), contact with animal, ingestion of undercooked meat, ingestion of water from contaminated source.

Line listing:

					Diagnostic							Lab		
					Signs and Symptoms									
Case#	Initials	Date of Report	Date of Onset	Physician Diagnosis	N	V	A	F	DU	J	HAIgM	Other	Age	Sex
1	JG	10/12	12/6	Hep A	+	+	+	+	+	+	+	SGOT ↓	37	M
2	BC	10/12	10/5	Hep A	+	-	+	+	+	+	+	Alt ↓	62	F
3	HP	10/13	10/4	Hep A	±	-	+	+	+	S*	+	SGOT ↓	30	F
4	MC	10/15	10/4	Hep A	-	-	+	+	?	-	+	Hbs/ Ag-	17	F
5	NG	10/15	10/9	NA	-	-	+	-	+	+	NA	NA	32	F
6	RD	10/15	10/8	Hep A	+	+	+	+	+	+	+		38	M
7	KR	10/16	10/13	Hep A	±	-	+	+	+	+	+	SGOT = 240	43	M

S*=Sclera;, N=Nausea; V=Vomiting; A=Anorexia; F=Fever; DU=Dark urine; J=Jaundice;
HAIgm=Hepatitis AIgM antibody test

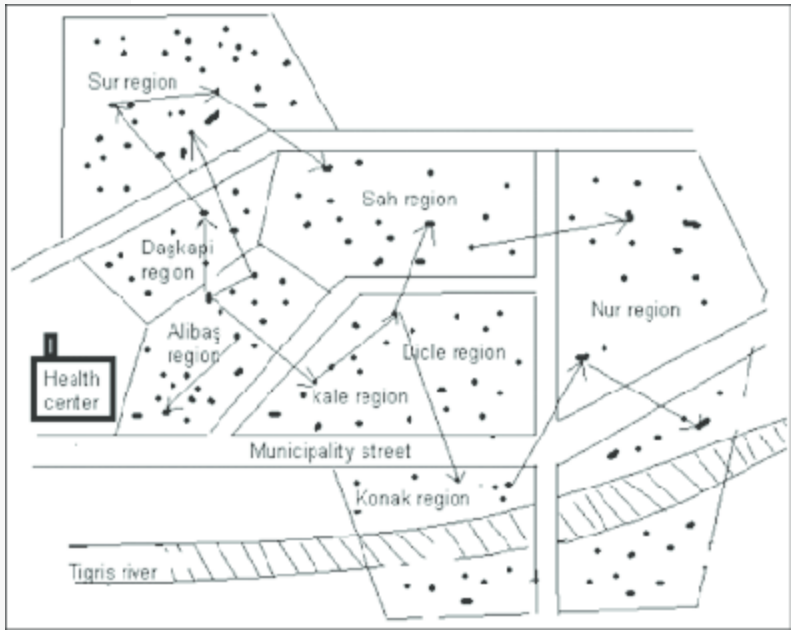
5. Describe and Analyze data

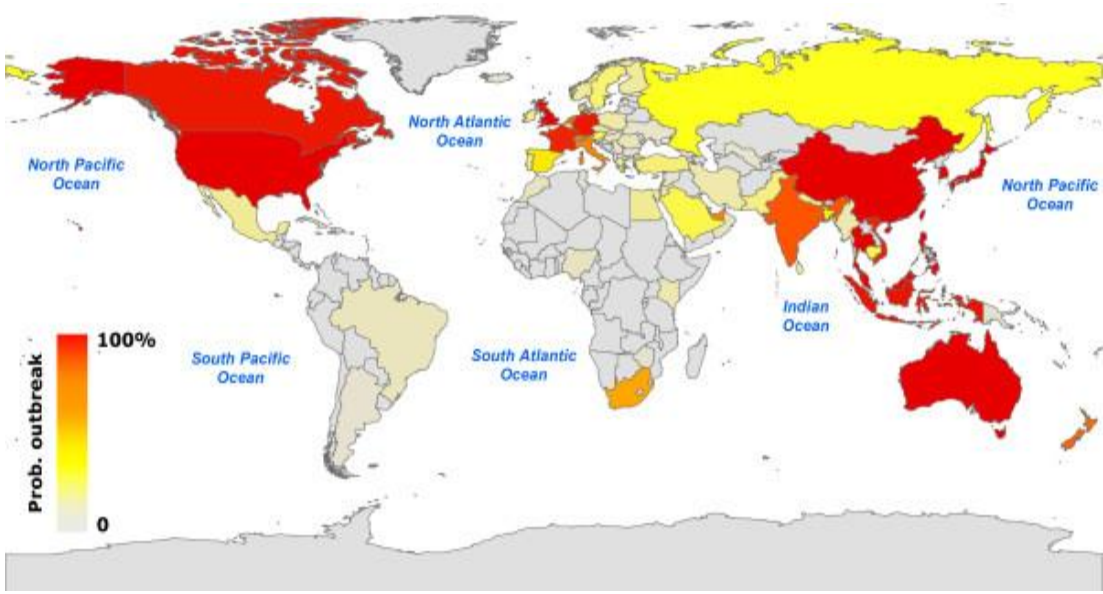
Descriptive analysis: Time, Place, person

Place:

- Place data can be included in line listing (text).
- Or a map to visualize the outbreak. (mapping)
- Two types:

- A spot map: A map that marks **individual cases** at specific locations based on certain characteristics, such as **where they live, work, or were exposed**
- An area map: A map that displays the **number of cases** aggregated by **geographical areas**, such as districts, neighborhoods, or regions.



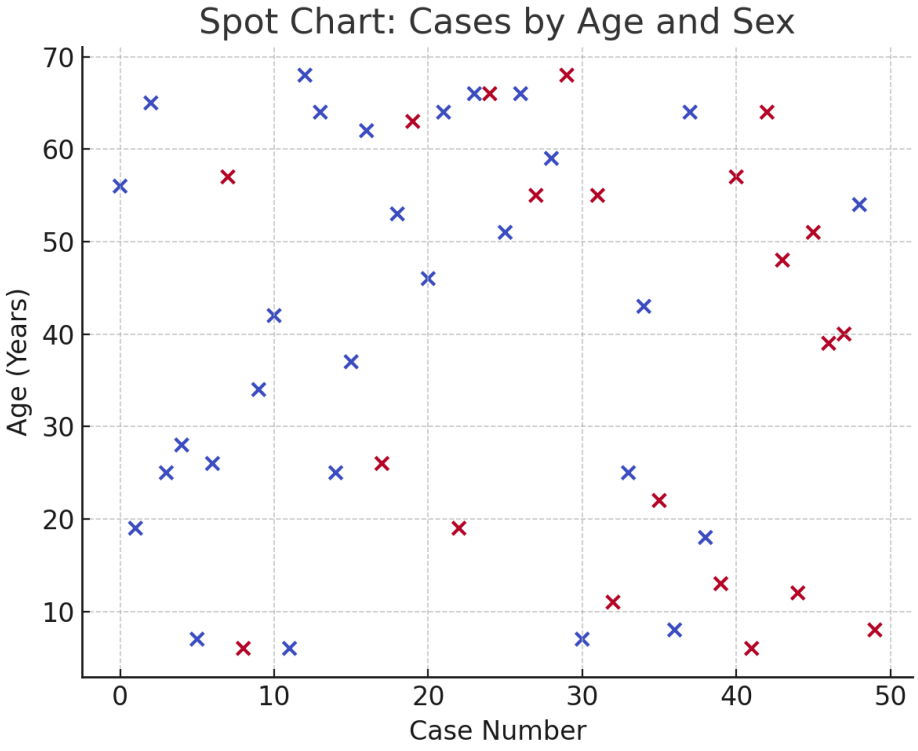


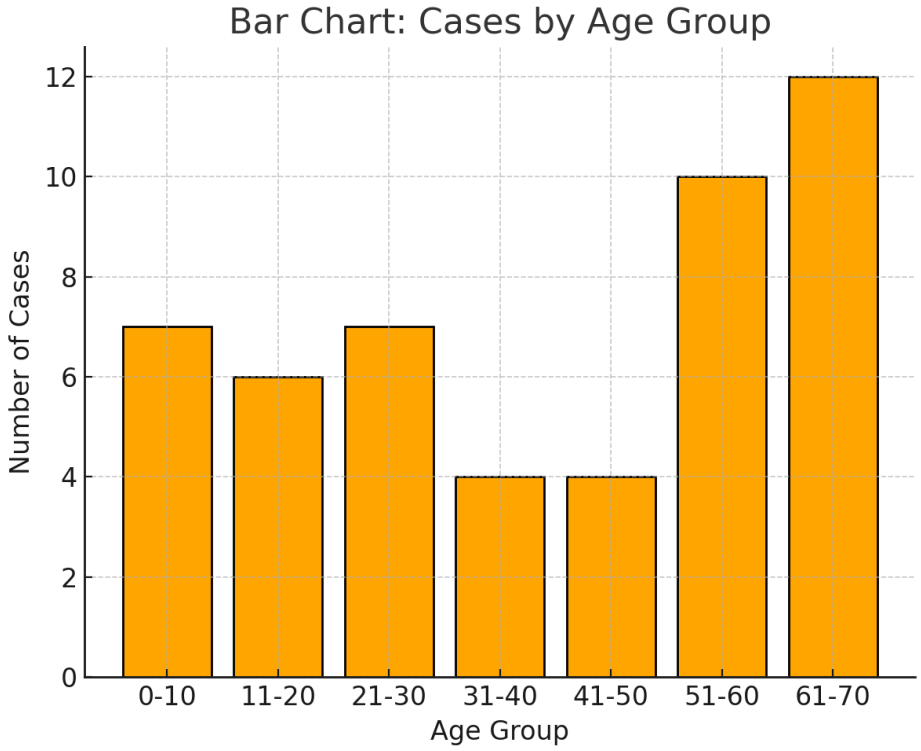
5. Describe and Analyze data

Descriptive analysis: Time, Place, person

Person:

- Age, sex, occupation, education, social class, economic class (income), marital status, race and ethnicity, underlying medications, and others. (Table or visually)





5. Describe and Analyze data

Descriptive analysis: Time, Place, person

Time

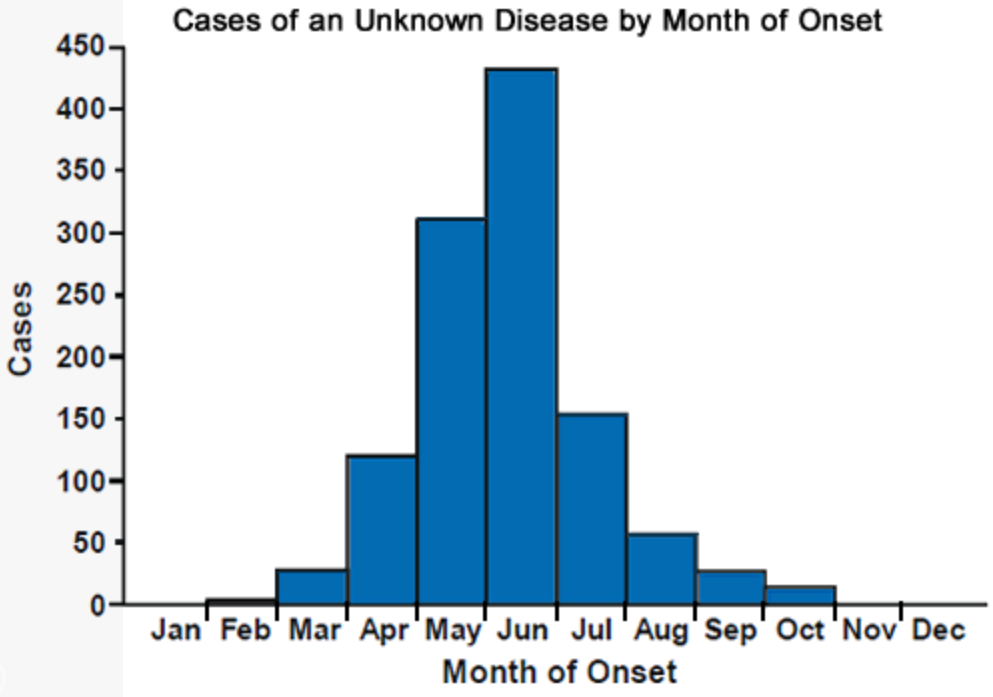
Epidemic curve

- An epidemic curve (epi curve) is a graphical display of the number of disease cases over time.
- An epi curve is a type of a histogram with the number of infected cases (y axis) by a selected time unit (x axis)
- The shape of the curve can give clues to the transmission route and source of the epidemic.
- Reports on the time course of an epidemic in a defined population

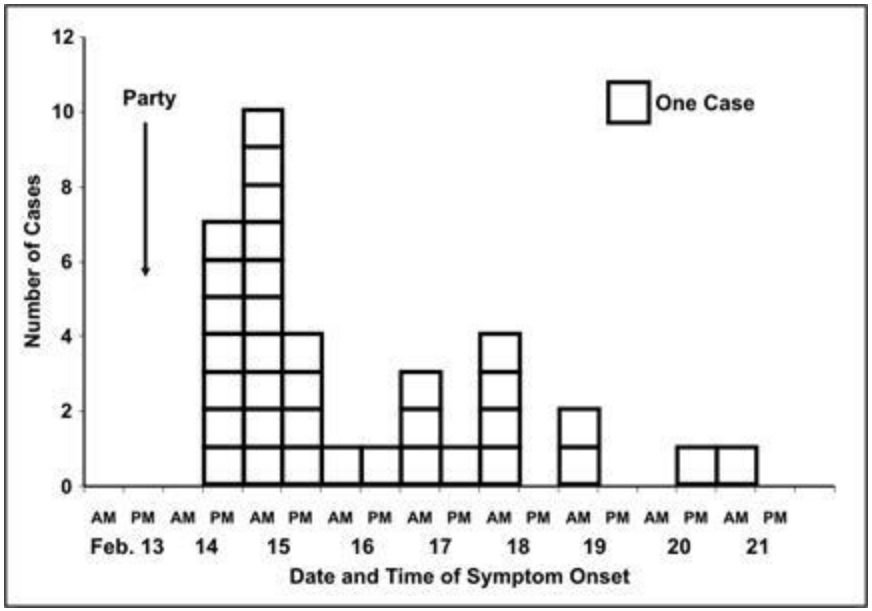
Time can be weeks, days, hours according to the incubation period. E.g. Bacillus cereus incubation period 1-6 hours

Epi curve: A histogram

Column histogram



Stacks of boxes histogram



Steps to Create an Epidemic Curve

Collect Data: Gather information on symptom onset dates.

Choose an Appropriate Time Interval:
Based on disease incubation period (e.g., hours, days, weeks..etc).

Plot the Data:
Use bars to represent case counts over time.

Analyze the Shape:
Look for patterns, peaks, and outliers.

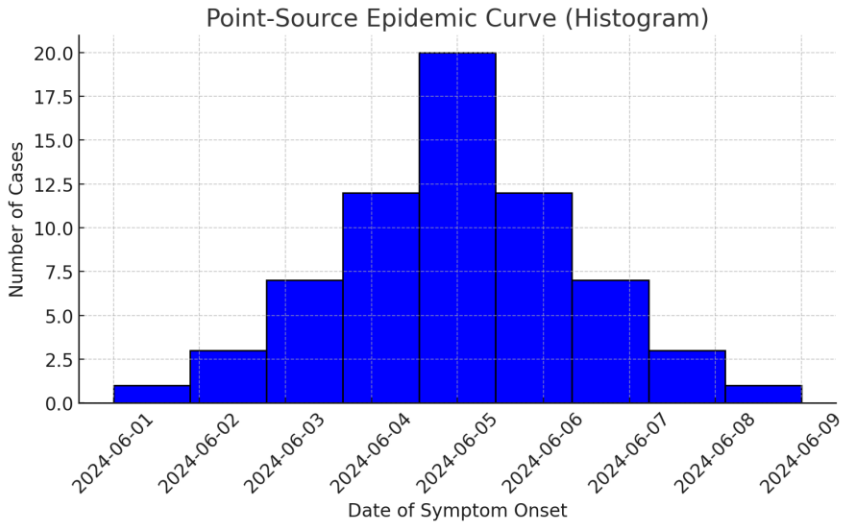
Patterns of Epi Curves:

Three common types of outbreak patterns:

- **1. Common Source Outbreak**

a. Point Source Outbreak

- A single exposure event, all cases occur within one incubation period.
- **Shape**: A sharp peak, followed by a decline.
- **Example**: Food poisoning at a wedding.



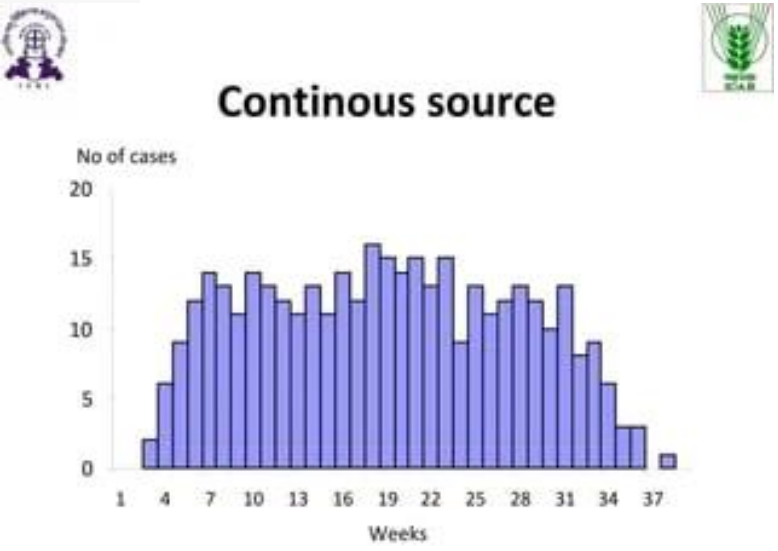
Patterns of Epi Curves:

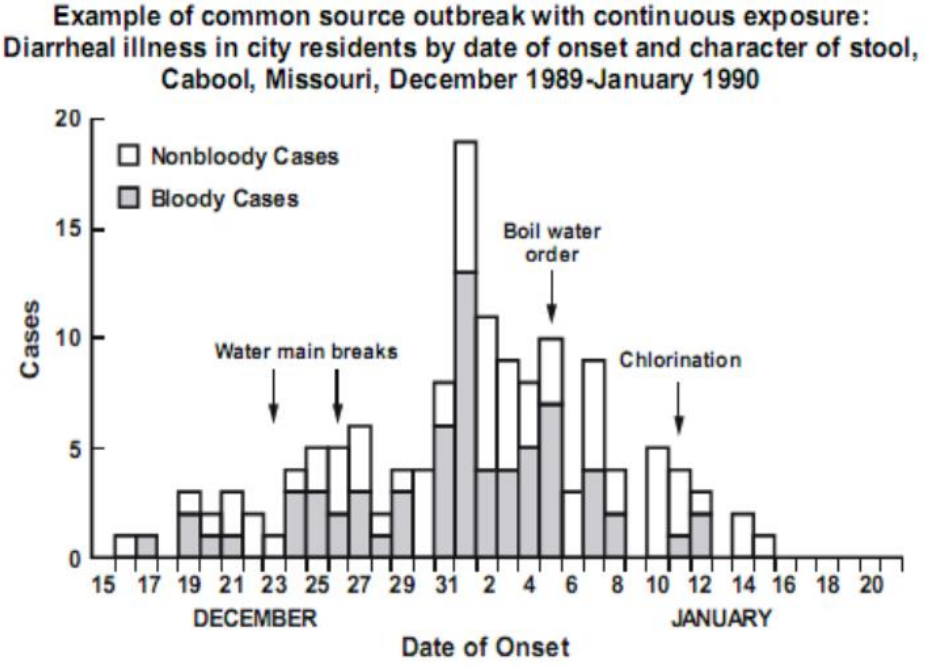
Three common types of outbreak patterns:

- **1. Common Source Outbreak**

b) Continuous Common Source

- Ongoing exposure to the source over a period. Multiple incubation periods.
- **Shape**: A plateau or gradual rise and fall.
- **Example**: Contaminated water supply.

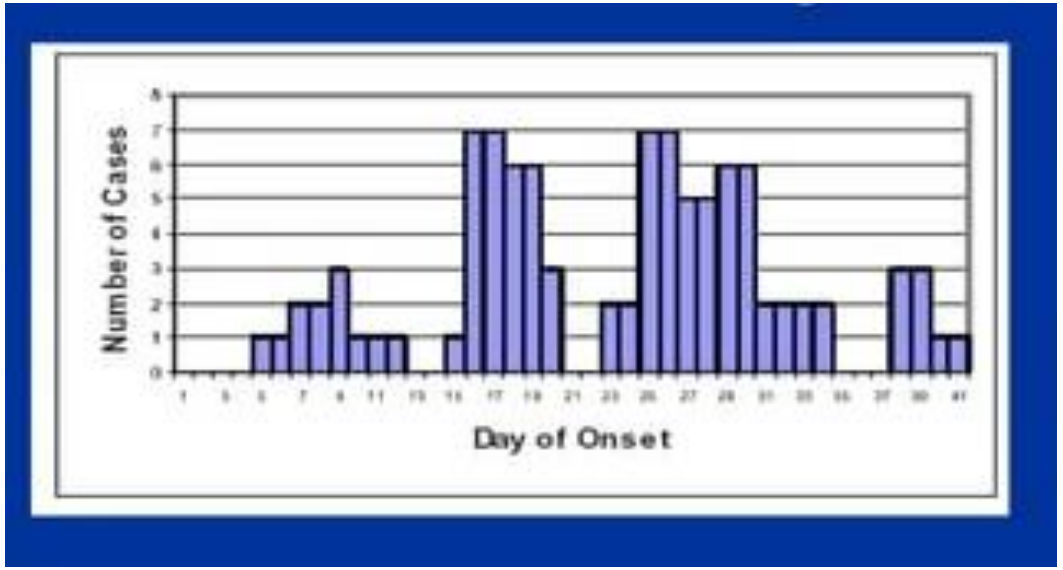




Patterns of Epi Curves:

Three common types of outbreak patterns:

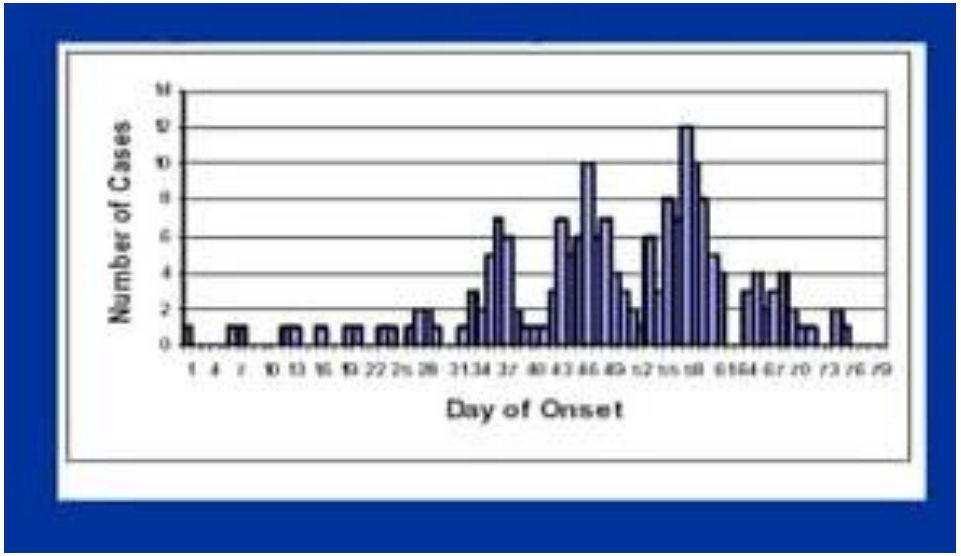
- **2. Intermittent Common Source**
- Exposure to the source occurs **intermittently** (not continuous or one-time).
- **Shape**: Irregular peaks separated by periods with no cases.
- **Example**: Sporadic contamination of food at a restaurant.

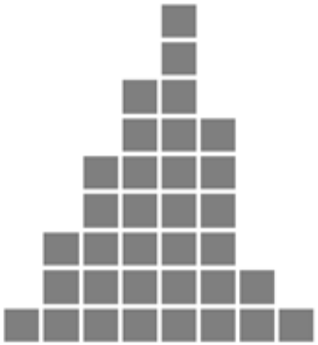


Patterns of Epi Curves:

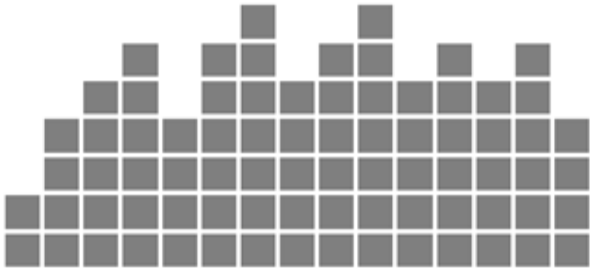
Three common types of outbreak patterns:

- **3. Propagated (Person-to-Person) Outbreak**
- Disease spreads from person to person.
- a single common source cannot be
- identified
- **Shape**: Multiple peaks (waves) occur, separated by incubation periods.
- Each wave represents new generations of transmission.
- **Example**: Measles, COVID-19, or influenza.

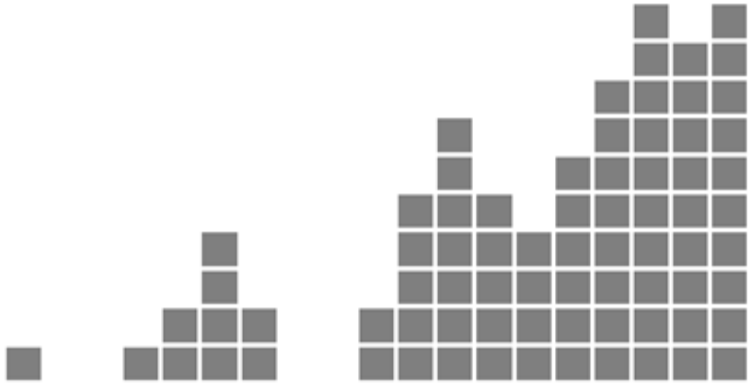




Point source



Continuous source



Propagated source

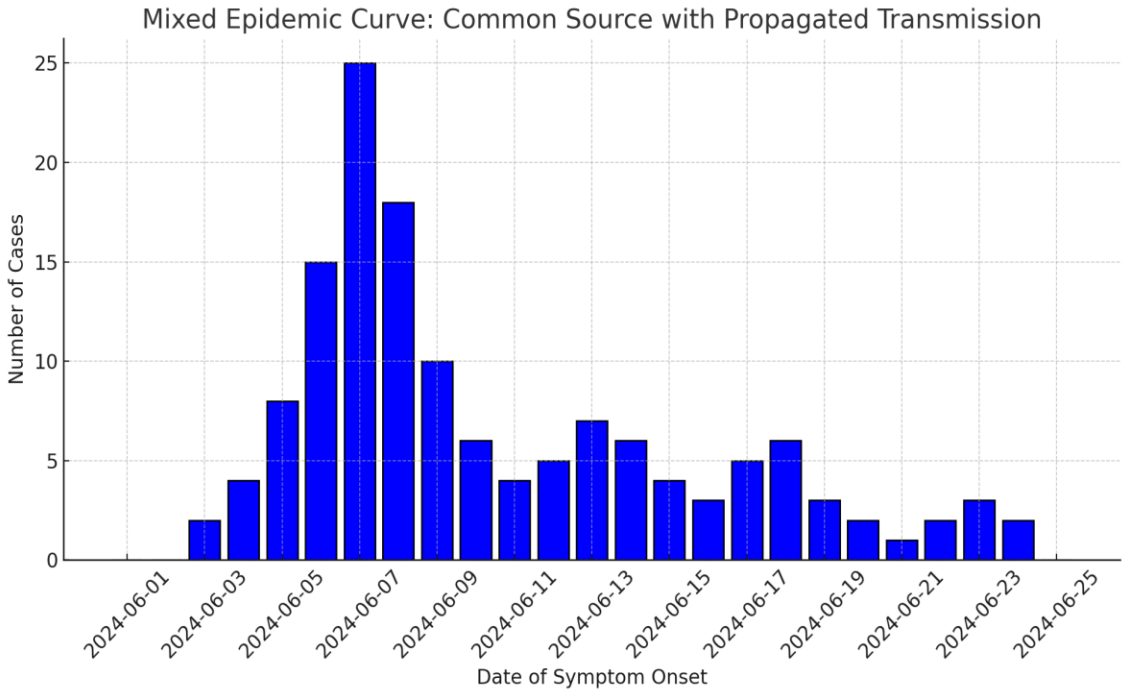
Intermittent source

Mixed Epidemic

- Initial Common-Source Exposure:
- Many individuals are exposed to a single source of infection (e.g., contaminated food or water).
- Followed by secondary cases caused by (propagated)person-to-person transmission.

Example: Cholera: People exposed to contaminated water initially (common source) may later spread the infection within households (propagated).

- Shape of the Epidemic Curve:
- The curve typically shows a sharp peak (indicating the common-source exposure), followed by successive smaller peaks as the disease spreads person-to-person. The smaller peaks represent the incubation period and multiple waves of transmission

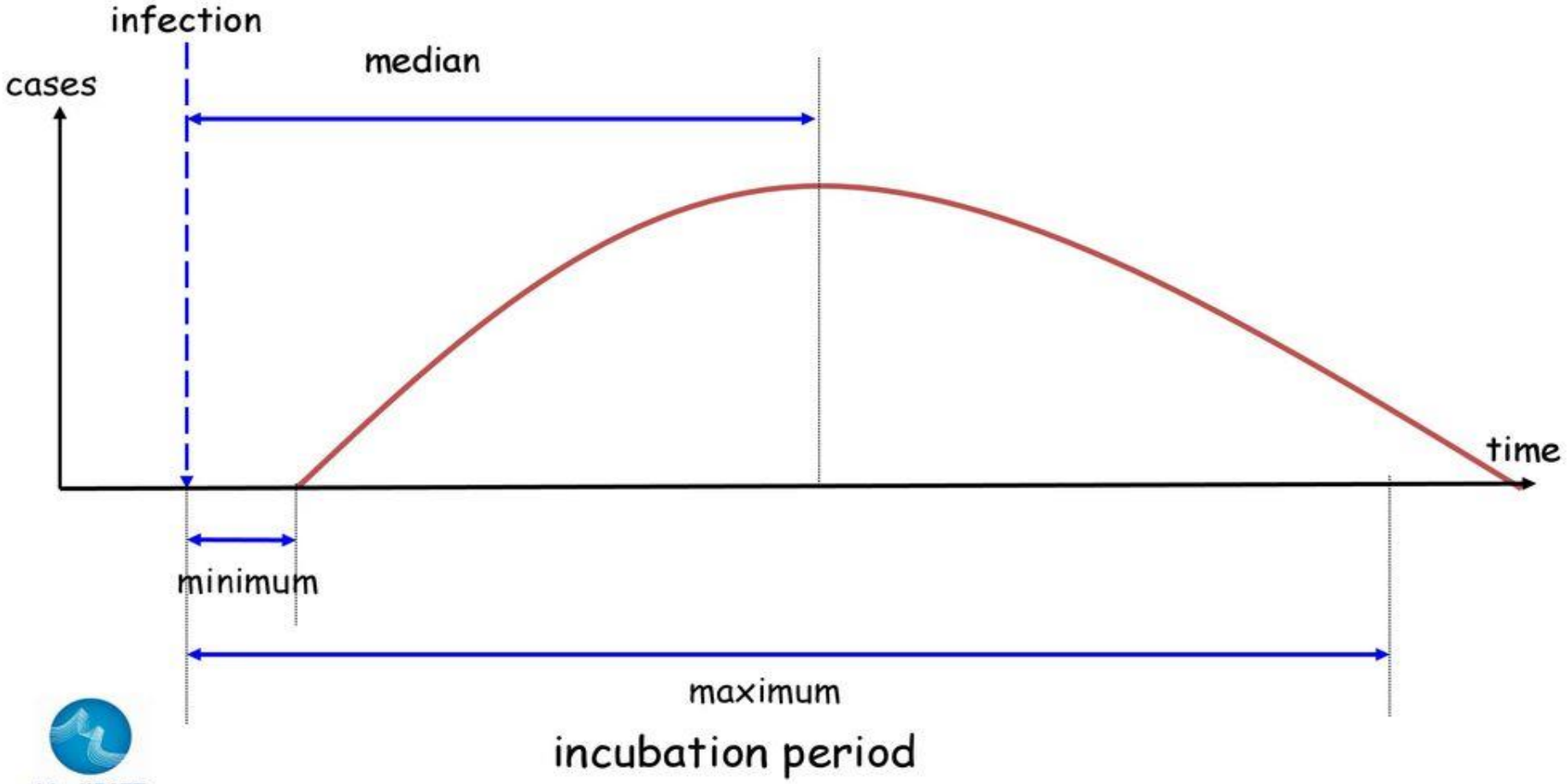


Estimating the Time of Exposure: Steps to Determine the Likely Exposure Period:

- Identify the Peak of the Outbreak: (Find the date with the highest number of cases on the epidemic curve.) This represents **the median** case.
- Count Back the Average Incubation Period: Look up the average incubation period for the disease.
- Count backward from the peak date on the x-axis to estimate the likely exposure date.
- **Adjust for Early Cases**:
- Identify the **earliest case** on the curve.
- Count backward using the **minimum incubation period** to estimate the earliest exposure date.

- **Example**
- **Disease**: Hepatitis A
- **Average Incubation Period**: 28 days
- **Minimum Incubation Period**: 15 days
- Peak Date (Median Case): June 30
- Earliest Case: June 25
- **Step 1: Peak = June 30 → Count back 28 days → Likely exposure: June 2.**
- **Step 2: Earliest case = June 25 → Count back 15 days → Earliest exposure: June 10.**
- **Conclusion: The likely exposure period is between June 2 and June 10.**

Frequency distribution of the incubation period

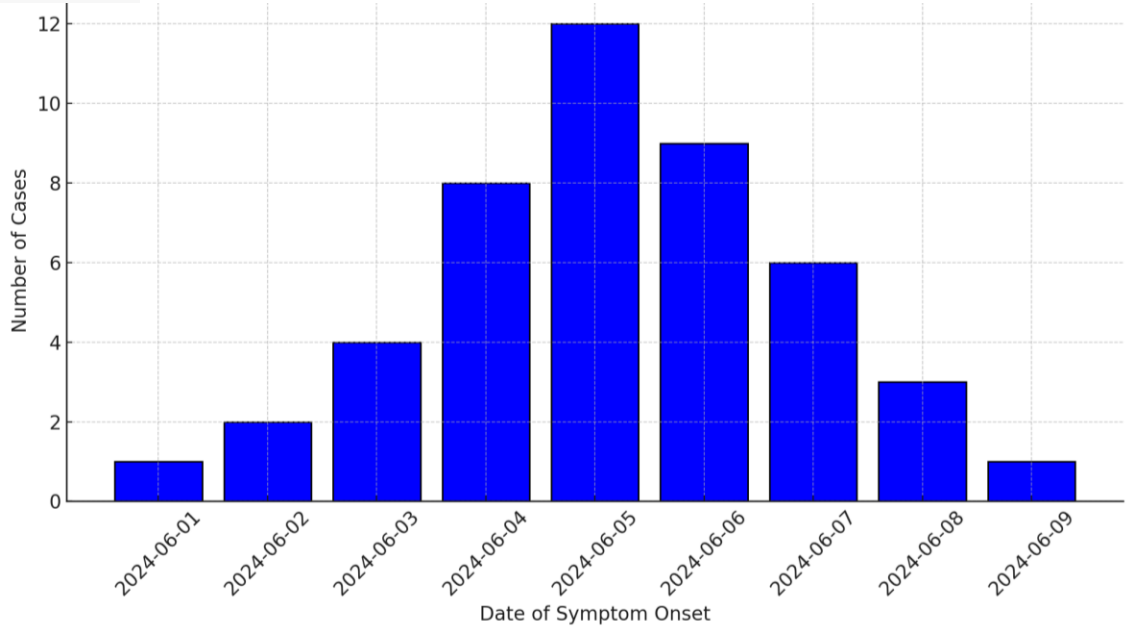


MediPIET

incubation period : The difference between maximum and minimum.

- Use the **Date** as the X-axis (time).
- Use the **Number of Cases** as the Y-axis (frequency of cases).
- Plot each date as a **bar**, where the height of the bar equals the number of cases.

Date	Number of Cases
June 1	1
June 2	2
June 3	4
June 4	8
June 5	12
June 6	9
June 7	6
June 8	3
June 9	1



- **What is the peak date?**
- June 5.
- **If the incubation period is 3 days, when might the exposure have occurred?**
- Count back 3 days from the peak (June 4 → June 1).
- **What type of outbreak is this?**
- Point source outbreak (sharp rise and fall of cases).

Steps 6, 7, 8, 9 and 10

- **Develop Hypotheses**
  - Generate theories about the **source of the outbreak**, **mode of transmission**, and **risk factors**.
  - Example: “The outbreak was caused by contaminated water from Reservoir X.”
- **Evaluate Hypotheses**
  - Test hypotheses using **analytic studies** like:
    - **Cohort Study**: Compare exposed and unexposed groups.
    - **Case-Control Study**: Compare cases (sick individuals) with controls (healthy individuals).
  - Calculate measures like **Relative Risk (RR)** and **Odds Ratio (OR)**.
- **Implement Control and Prevention Measures**
  - Apply measures to stop the outbreak:
    - Isolation, vaccination, sanitation, or public health messaging.
- **Communicate Findings**
  - Prepare and share reports with stakeholders, public health authorities, and the community.
  - Use visual tools like epidemic curves, maps, and tables.
- **Follow Up and Monitor**
- Ensure control measures are effective.
- Monitor for additional cases to prevent recurrence.

Thank you