OUTBREAK INVESTIGATION

Done by: Yusra Kayyali

LECTURE OBJECTIVES:

At the end of the lecture the student should be able to:

- **Recognize the importance of investigating reported outbreaks**
- **Understand steps in the investigation of an outbreak**
- **Describe epidemic curves**

An **outbreak** or an **epidemic** is the occurrence of **more cases of disease than expected** in a given area or among a specific group of people over a particular period of time.
Example of an outbreak: H1N1, influenza after hajj.

A **cluster** is **an aggregation** of cases in a given area over a particular period **without** regard to whether the number of cases is more than expected.
Example: scabies (skin disease) found in clusters in 2 houses, it usually isn't found all the time in the community and even if it spreads it would not spread to many people thus it is not considered an epidemic nor an outbreak.

TO INVESTIGATE OR NOT TO?

"***Outbreak investigations, an important and challenging component of epidemiology and public health, can help identify the source of ongoing outbreaks and prevent additional cases. Even when an outbreak is over, a thorough epidemiologic and environmental investigation often can increase our knowledge of a given disease and prevent future outbreaks. Finally, outbreak investigations provide epidemiologic training and foster cooperation between the clinical and public health communities.***"

Outbreak Investigations—A Perspective
Arthur L. Reingold
University of California, Berkeley
Emerging Infectious Diseases, Vol. 4 , No. 1

Example: Scabies does not need to be investigated, however flu can cause morbidity and if aggravated can cause pneumonia or asthma and people may die therefore it can be investigated.
Investigation can increase our information about the problem even after it is done, it can help explain causes of why it happened, investigations can help in future prevention.

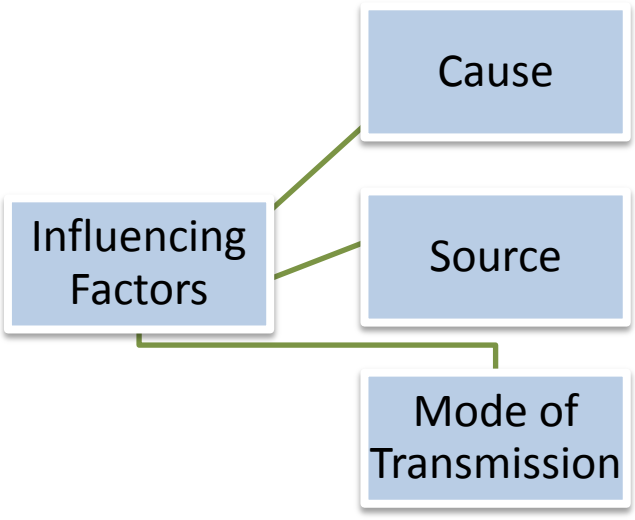
WHY TO INVESTIGATE?

- Control & Prevention
- Research Opportunities
- Training
- Public/Legal/Political Concerns

Training the interns, residents, doctors, and nursing staff how to identify, address and handle it immediately.

CONTROL VS. FURTHER INVESTIGATIONS

We focus on control when we know all the facts we need, but we do further investigations when any of the influencing factors is unknown.



- If all are known we only control.
- If the source and mode of transmission are unknown but the ***causative agent is known*** we still need to investigate before controlling.
- If the ***source and mode of infection are known*** but the causative agent is unknown then we investigate as well as control.
- If 2 or all 3 are unknown we need to investigate and train before controlling.

Table 6.1 Relative Priority of Investigative and Control Efforts During an Outbreak, Based on Knowledge of the Source, Mode of Transmission, and Causative Agent

		Source/Mode of Transmission (How people are getting exposed to the agent)	
		Known	Unknown
Causative Agent	Known	Investigation + Control +++	Investigation +++ Control +
	Unknown	Investigation +++ Control +++	Investigation +++ Control +

+++ = highest priority
+ = lowest priority

Source: Goodman RA, Buehler JW, Koplan JP. The epidemiologic field investigation: science and judgment in public health practice. Am J Epidemiol 1990;132:9–16.

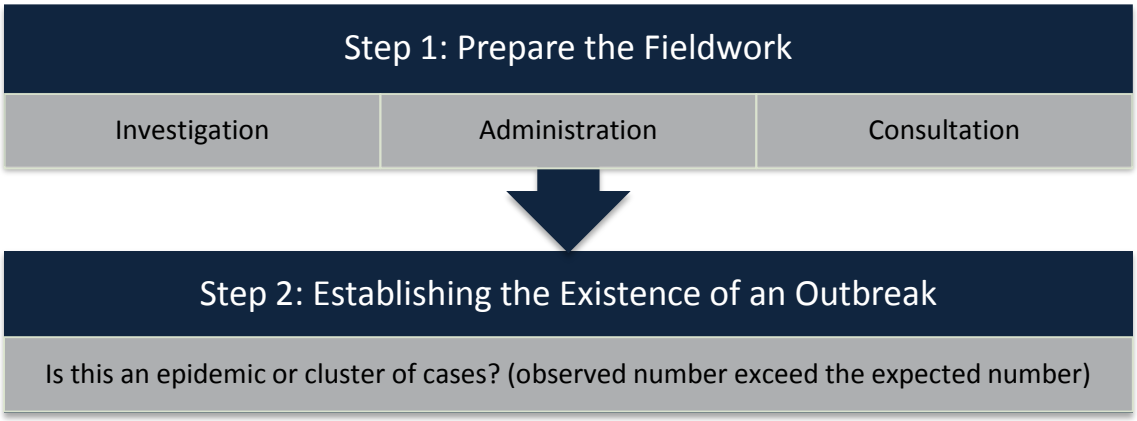
Once a decision is made to investigate an outbreak

- *The epidemiologic investigation.* (time, person and place)
- The environmental investigation.
- The interaction with the public, the press, and, in many instances, the legal system.

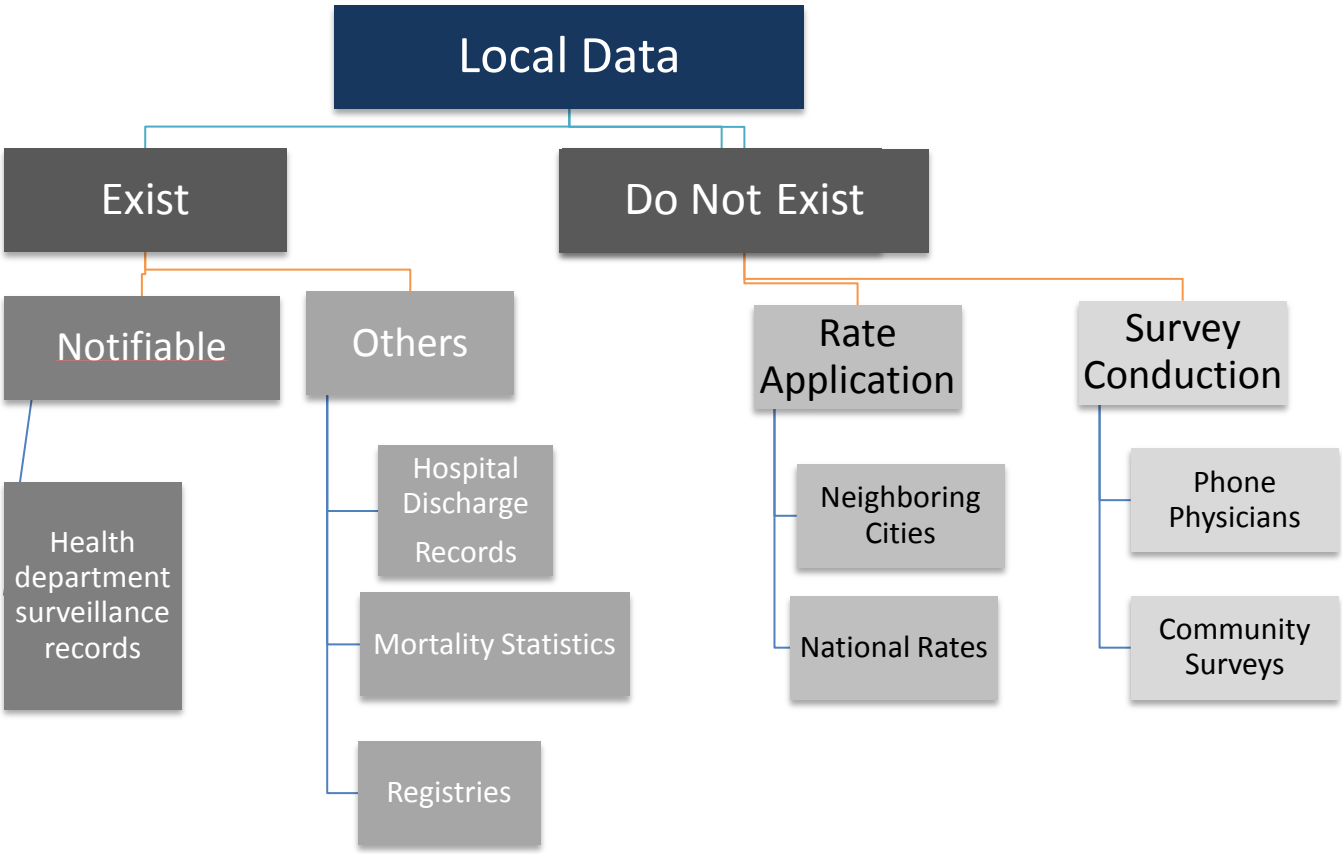
VERY IMPORTANT TABLE MEMORISE IT

Table 6.2
Steps of an outbreak investigation

1. Prepare for field work
2. Establish the existence of an outbreak
3. Verify the diagnosis
4. Define and identify cases
   a. establish a case definition
   b. identify and count cases
5. Perform descriptive epidemiology
6. Develop hypotheses
7. Evaluate hypotheses
8. As necessary, reconsider/refine hypotheses and execute additional studies
   a. additional epidemiologic studies
   b. other types of studies – laboratory, environmental
9. Implement control and prevention measures
10. Communicate findings



Sources to Answer step 2



Continuation of sources to answer step 2

- For a notifiable disease: use health department surveillance records.
- For other diseases and conditions: find existing data locally—hospital discharge records, mortality statistics, cancer or birth defect registries.
- If local data are not available: apply rates from neighboring cities or national data, or, alternatively, conduct a telephone survey of physicians to determine whether they have seen more cases of the disease than usual.
- Finally, conduct a survey of the community to establish the background or historical level of disease.

Step 3: Verifying the Diagnosis

closely linked to verifying the existence of an outbreak

IMPORTANCE OF STEP 3:

- To ensure that the problem has been properly diagnosed
- To rule out laboratory error as the basis for the increase in diagnosed cases

STEPS OF VERIFICATION:

① Review the clinical findings and laboratory results.
② Visit several patients with the disease.
③ summarize the clinical findings with frequency distributions

WHY?

- Diseases can be misdiagnosed.
- Case may not be actual case, but rather suspected case.
- Information from non-cases must be excluded from the case information used to confirm the presence or absence of an epidemic.

Step 4 (a): Establishing a Case Definition		
Definition	Components	Terminology

Step 4 (b): Identifying and Counting Cases		
Sources for Identification	Information Collected	Line Listing (counting)

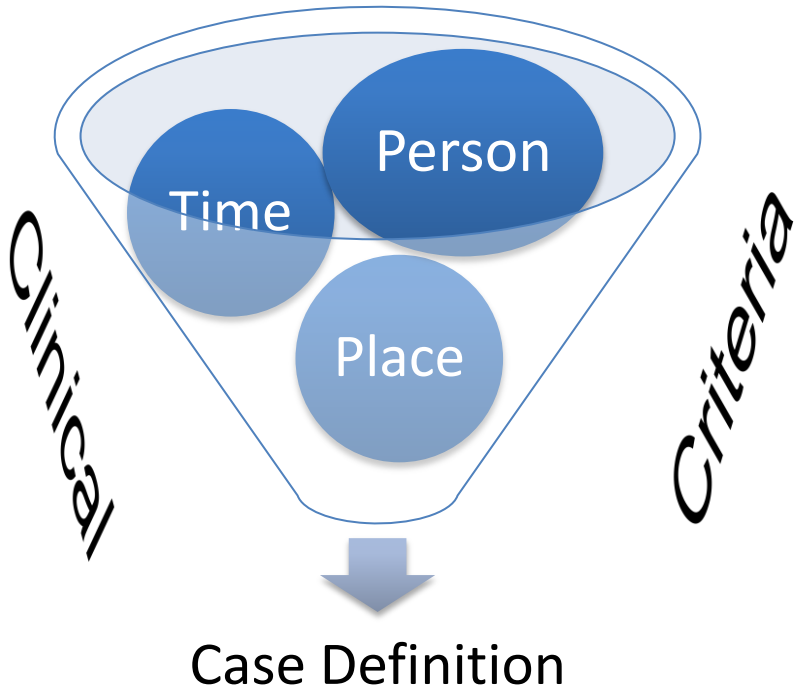
STEP 4 (a) WHAT IS A CASE DEFINITION

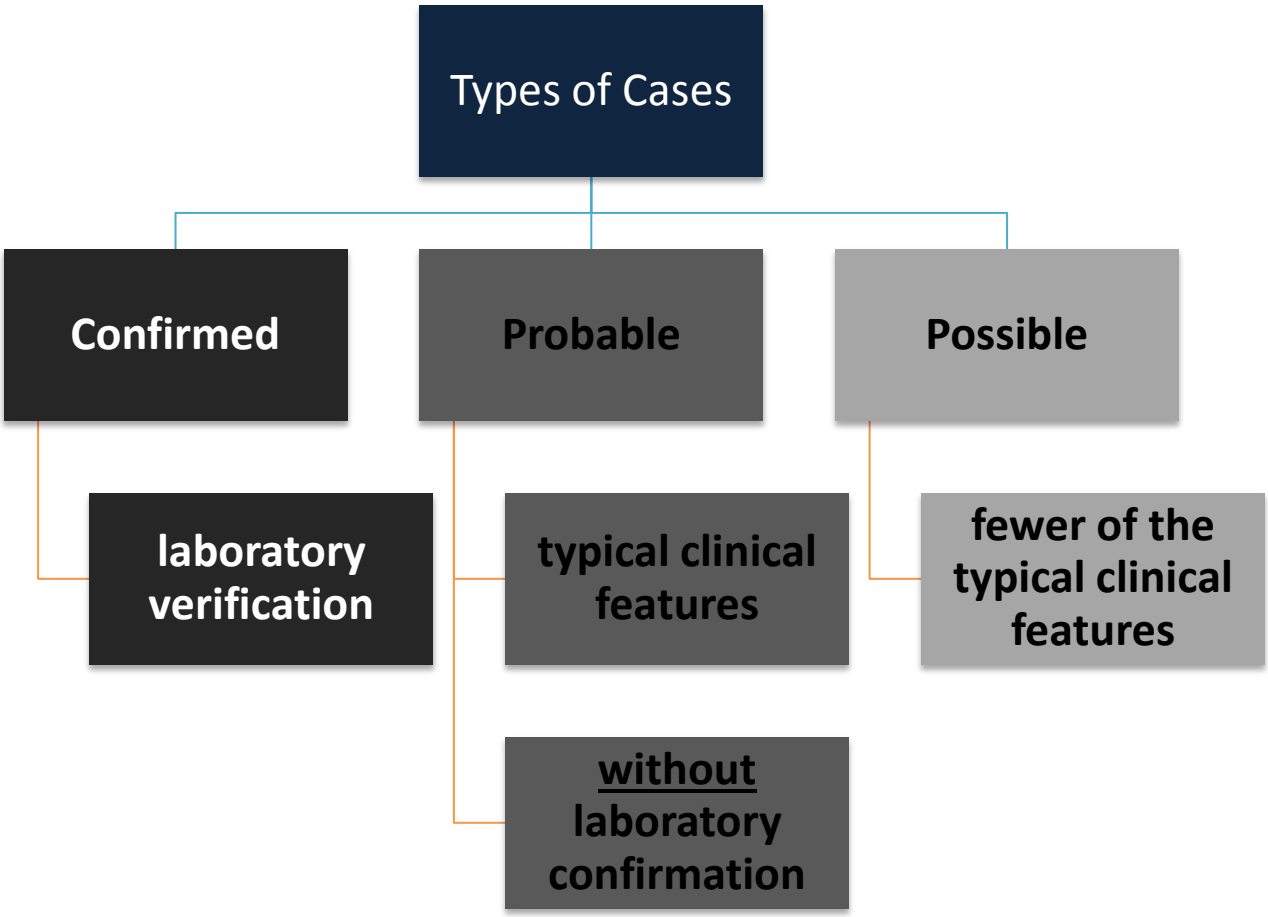
A standard set of criteria for deciding whether an individual should be classified as having the health condition of interest.

STEP 4 (A): COMPONENTS OF A CASE DEFINITION

A case definition includes **clinical criteria and--particularly in the setting of an outbreak investigation--restrictions by time, place and person.**

Apply them consistently and without bias to all persons under investigation.

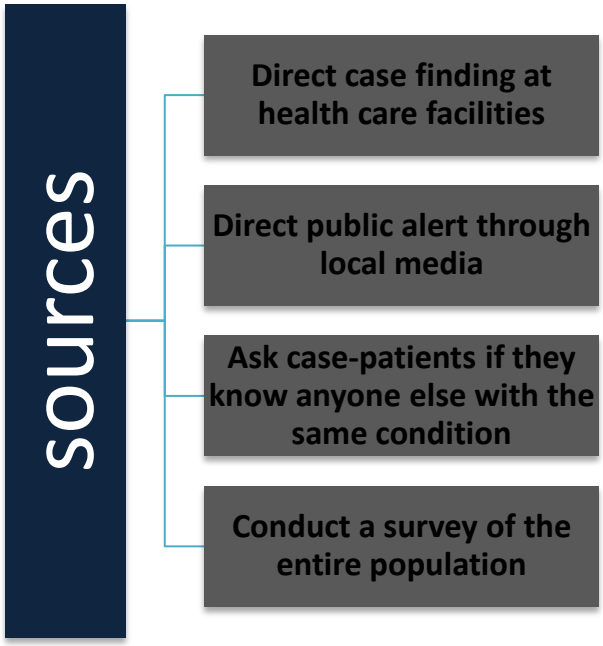




REMEMBER!

Early in an investigation, investigators often use a sensitive or "loose" case definition which includes confirmed, probable, and even possible cases. Later on, when hypotheses have come into sharper focus, the investigator may "tighten" the case definition by dropping the possible category.

STEP 4 (B): SOURCES FOR IDENTIFYING CASES



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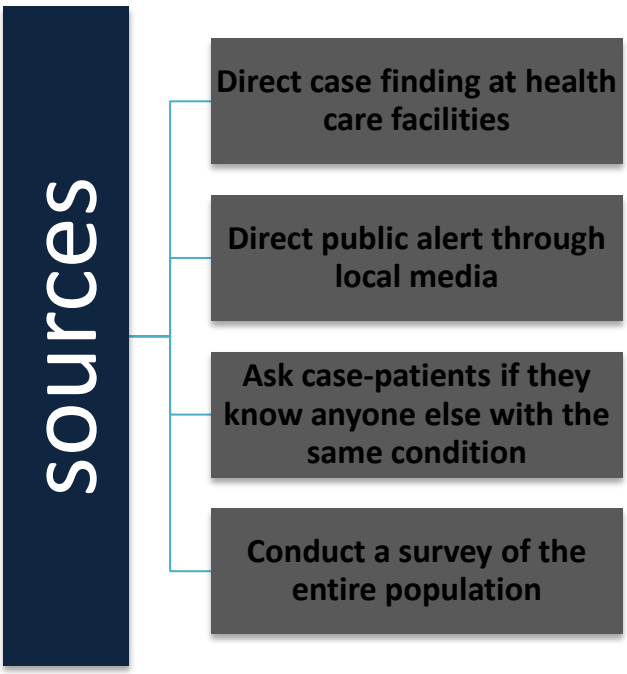
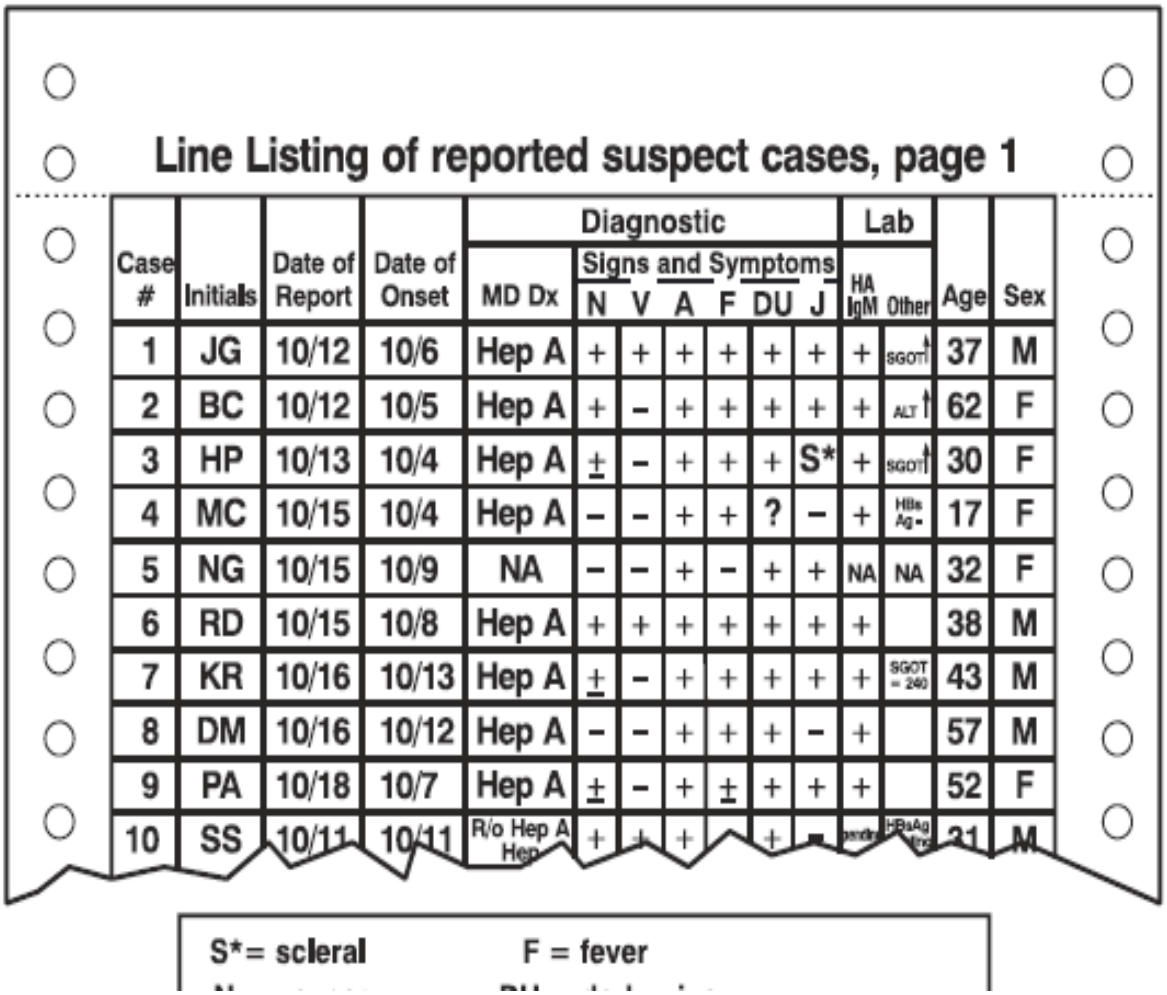


STEP 4 (B): LINE LISTING (COUNTING CASES)

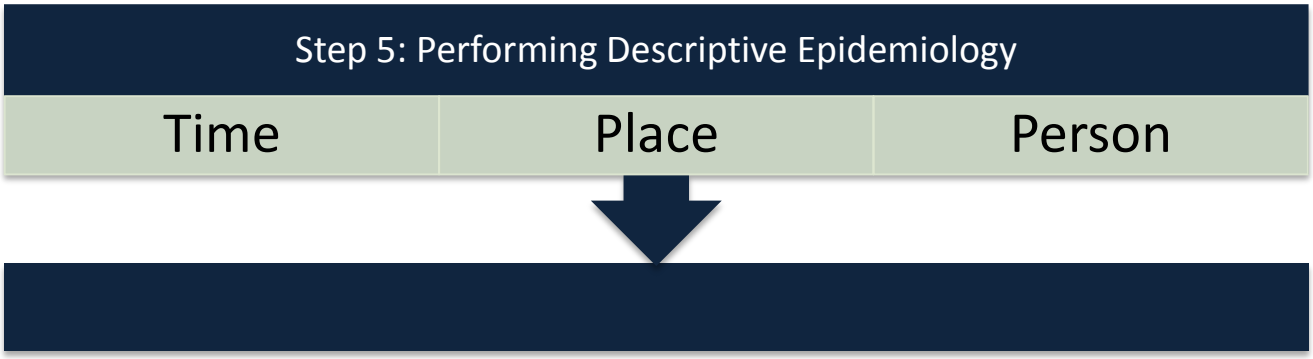


Line Listing of reported suspect cases, page 1

Case #	Initials	Date of Report	Date of Onset	Diagnostic							Lab		Age	Sex
				MD Dx	Signs and Symptoms						HA IgM	Other		
					N	V	A	F	DU	J				
1	JG	10/12	10/6	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
8	DM	10/16	10/12	Hep A	–	–	+	+	+	–	+		57	M
9	PA	10/18	10/7	Hep A	±	–	+	±	+	+	+		52	F
10	SS	10/11	10/11	R/o Hep A Hep	+	+	+		+	–		HBsAg	31	M

S*= scleral F = fever

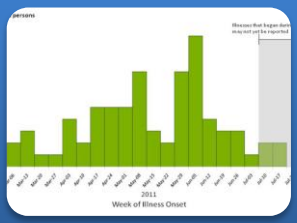
STEP 5



WHY WE NEED TO PERFORM STEP 5

Become familiar with the data

- By inspecting and looking carefully at them



Trend of the disease

- portraying its trend over time
- its geographic extent (place)
- the populations (persons) affected by the disease

Hypotheses Development

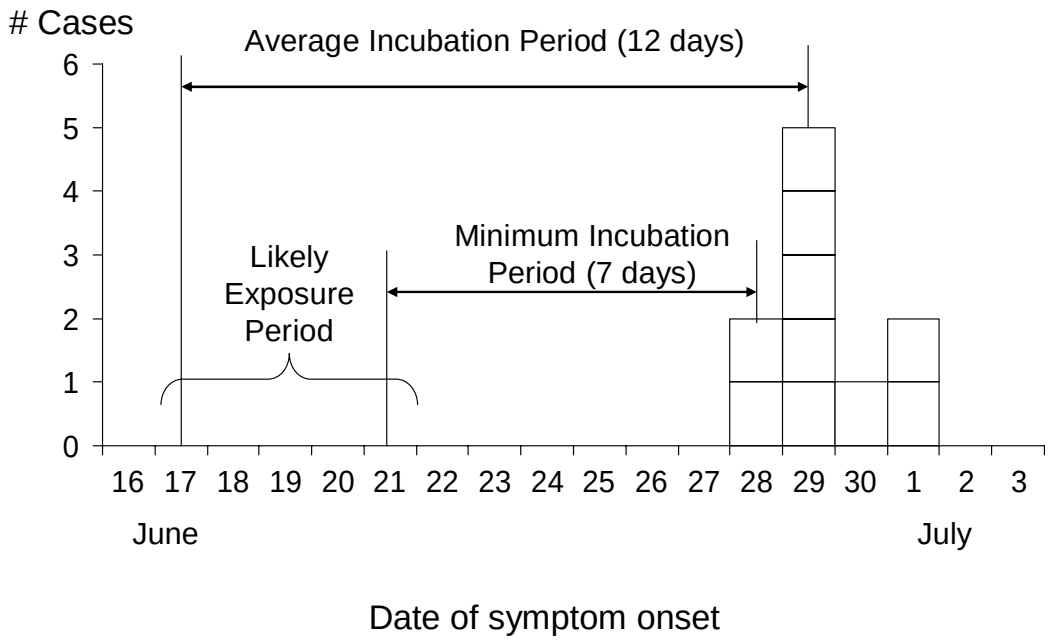
- Assess description of the outbreak in light of what is known about the disease (usual source, mode of transmission, risk factors and populations affected, etc.)

To identify the likely period of exposure from an epidemic curve

TO IDENTIFY THE LIKELY PERIOD OF EXPOSURE FROM AN EPIDEMIC CURVE

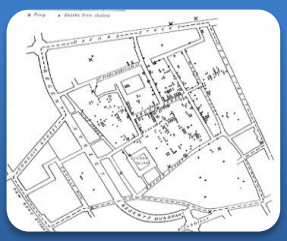
1. Look up the average and minimum incubation periods of the disease. This information can be found in *Control of Communicable Diseases in Manual.*
2. Identify the *peak of the outbreak* or the *median case* and count back on the *x*-axis one average incubation period. Note the date
3. Start at *the earliest case* of the epidemic and count back the minimum incubation period, and note this date as well.

AN OUTBREAK OF AN ACUTE RESPIRATORY DISEASE



Time

- What is the exact period of the outbreak?
- What is the probable period of exposure?
- Is the outbreak likely common source or propagated?



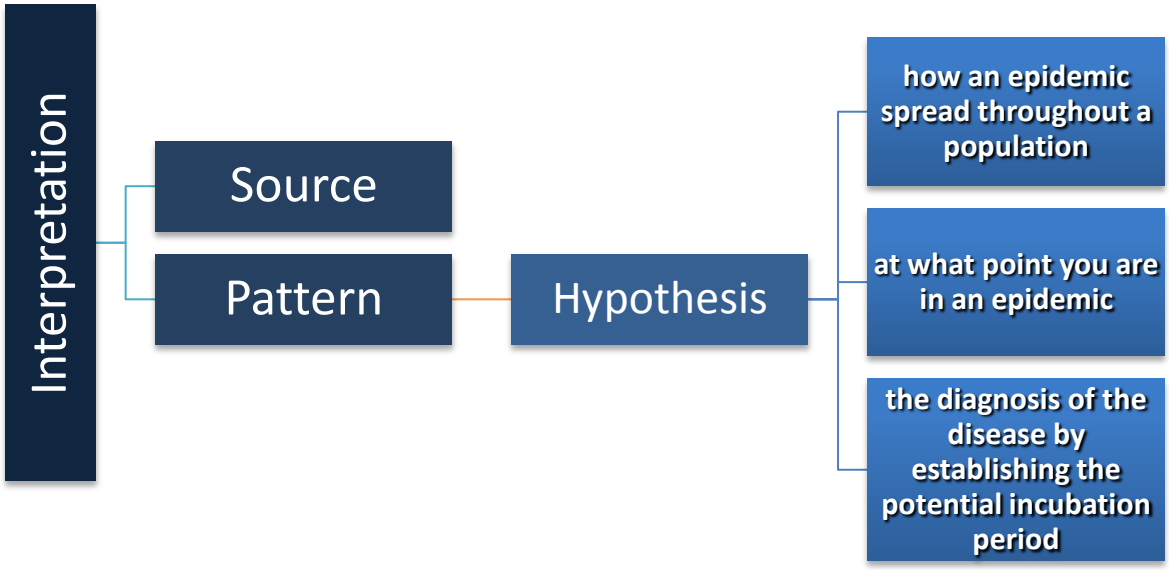
Place

- What is the most significant geographic distribution of cases? Place of residence? Workplace?
- What are the attack rates?

Person

- What were the age and gender specific attack rates?
- What age and gender groups are at highest and lowest risk if illness?
- In what other ways do the characteristics of the cases differ significantly from those of the general population?

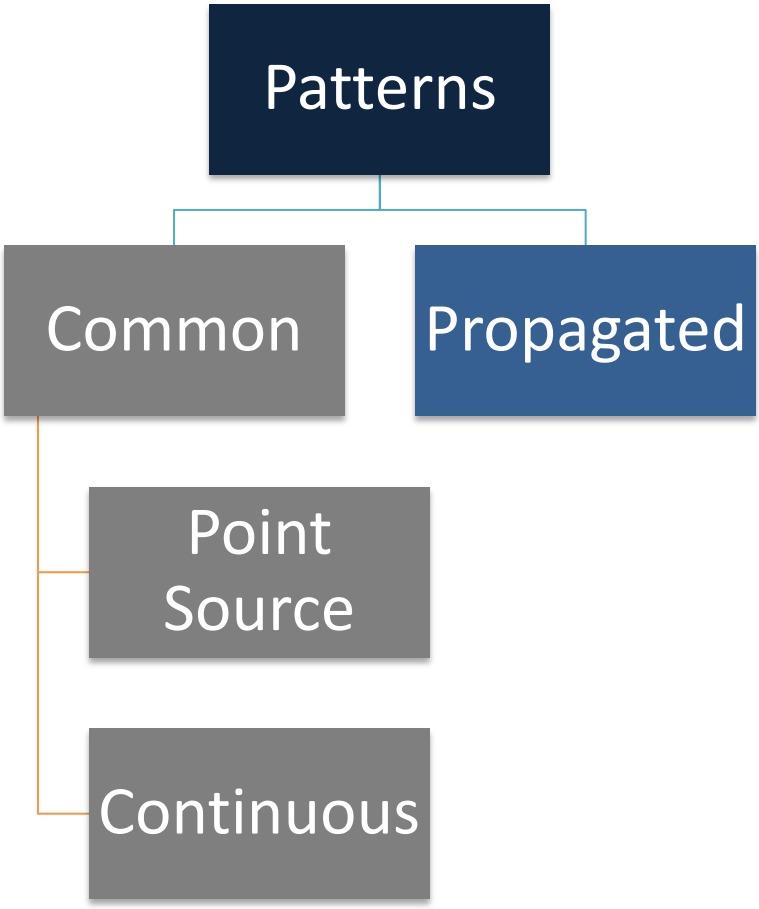
INTERPRETING AN EPIDEMIC CURVE



REMEMBER!

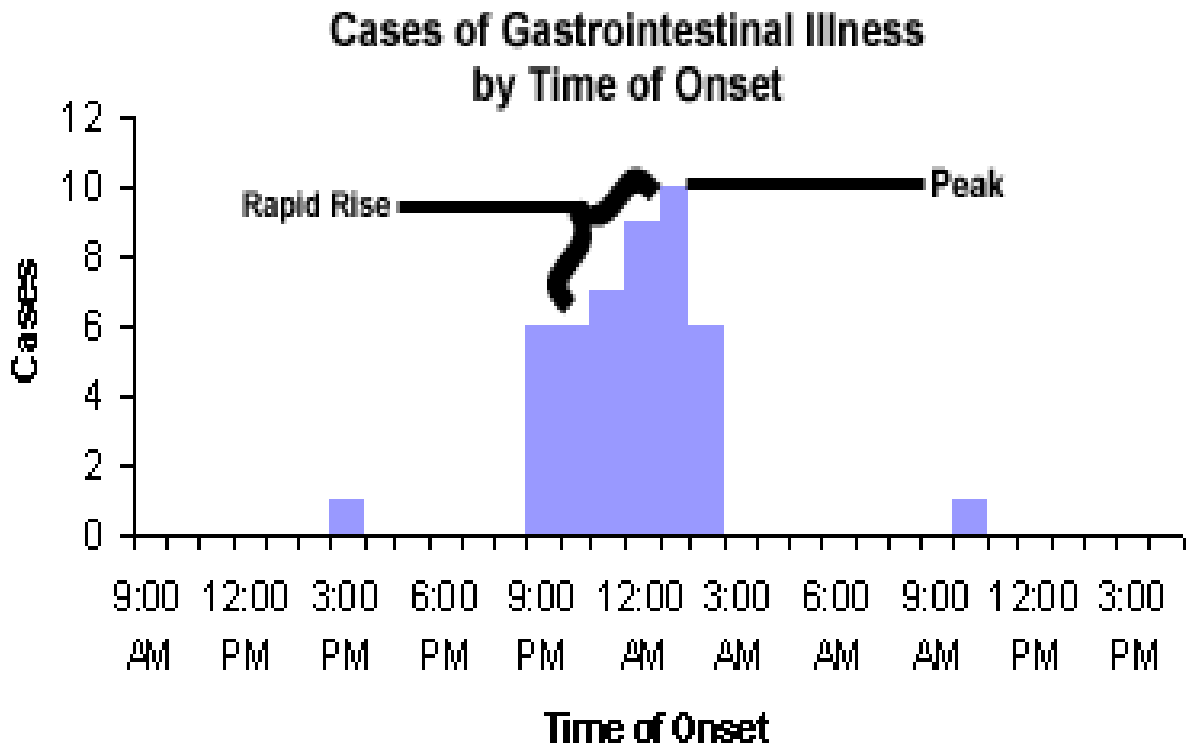
- When analyzing an epidemic curve, it is important to consider the following factors to assist in interpreting an outbreak:
  - ➔ The overall pattern of the epidemic
  - ➔ The time period when the persons were exposed
  - ➔ If there are any outliers

EPIDEMIC PATTERNS



POINT COMMON SOURCE

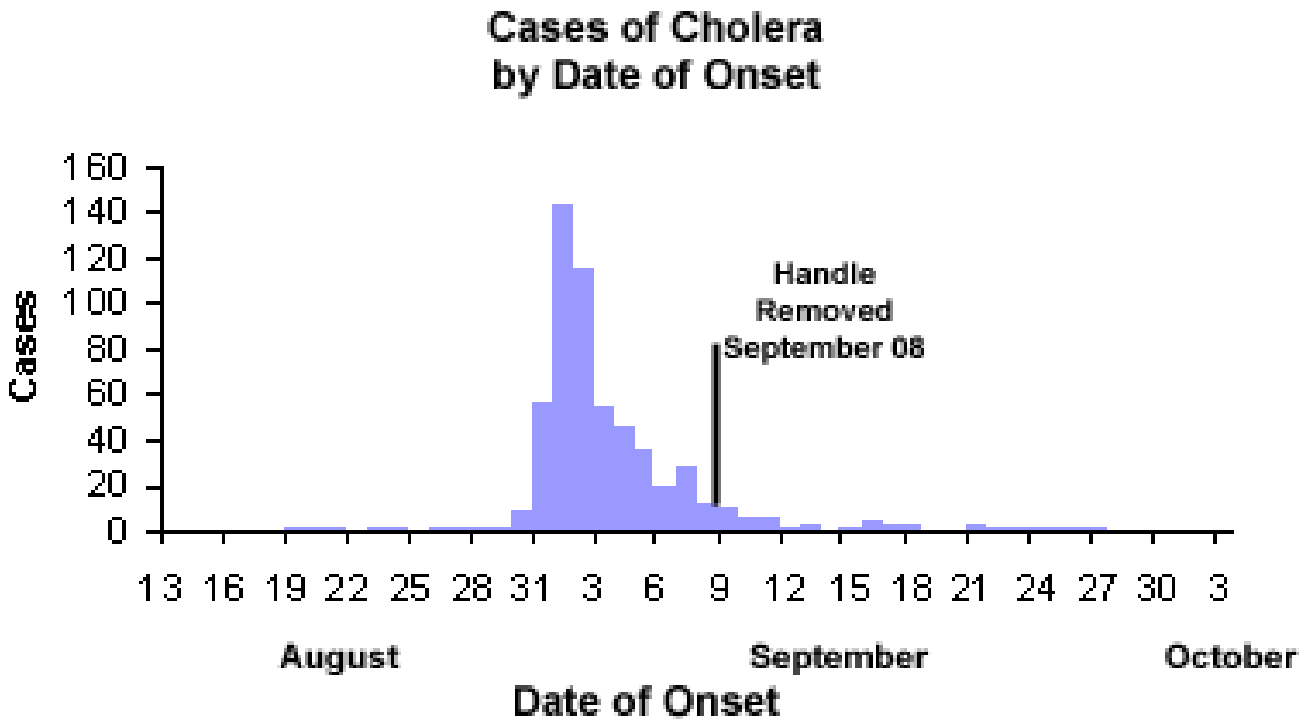
In a point source epidemic, persons are exposed to the same exposure over a limited, defined period of time, usually within one incubation period. The shape of this curve commonly rises rapidly and contains a definite peak at the top, followed by a gradual decline.



The graph above illustrates an outbreak of gastrointestinal illness from a single exposure. While there are outliers to this dataset, it is clear that there is an outbreak over a limited period of time, and the shape of the curve is characteristic of one source of exposure.

CONTINUOUS COMMON SOURCE

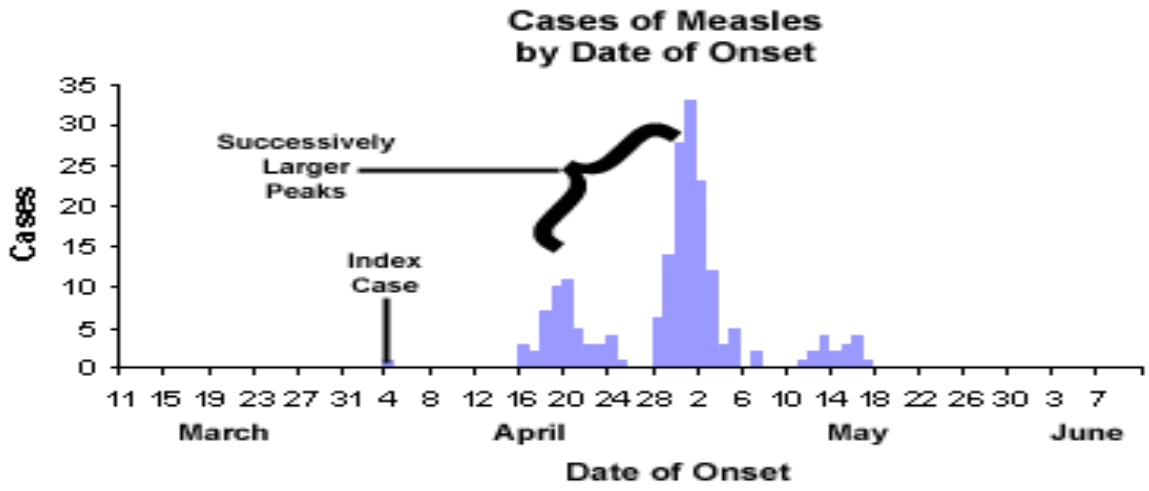
In a continuous common source epidemic, exposure to the source is prolonged over an extended period of time and may occur over more than one incubation period. The down slope of the curve may be very sharp if the common source is removed or gradual if the outbreak is allowed to exhaust itself.



The data above is from the well-known outbreak of cholera in London that was investigated by the "father of epidemiology," John Snow. Cholera spread from a water source for an extended period of time. Note that the typical incubation period for cholera is 1--3 days that the duration of this outbreak was more than 1 month.

PROPAGATED (PROGRESSIVE SOURCE)

A propagated (progressive source) epidemic occurs when a case of disease serves as a source of infection for subsequent cases and those subsequent cases, in turn, serve as sources for later cases. The shape of the curve usually contains a series of successively larger peaks, reflective of the increasing number of cases caused by person-to-person contact, until the pool of susceptible is exhausted or control measures are implemented.



The graph above illustrates an outbreak of measles. The graph shows a single common source (the index case), and the cases appear to increase exponentially. Measles is caused by person-to-person contact. Its incubation period is typically 10 days but may be 7--18 days.

Common Source Questions

- Is the outbreak from a single source or common source?
- Is the disease spread from person to person?
- Is there continued exposure to a single source?

PROPAGATED SOURCE QUESTIONS:

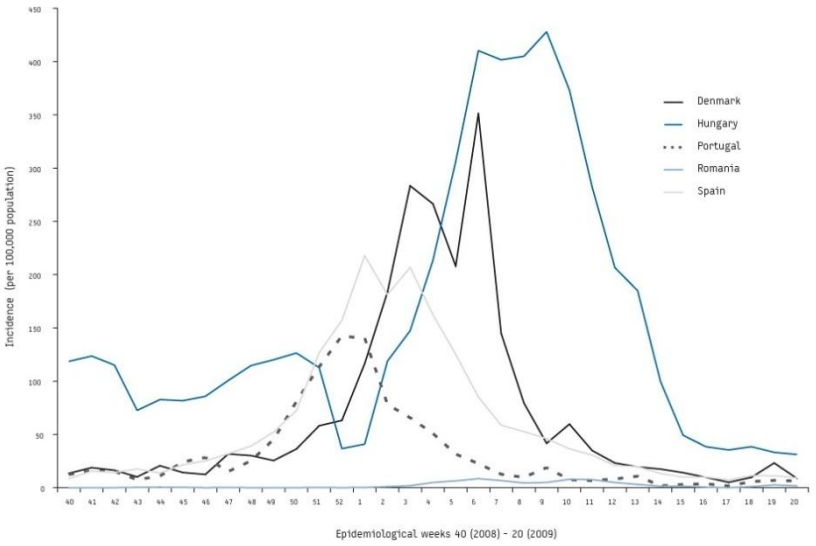
- Is the outbreak from multiple sources or exposures?
- Is the outbreak airborne, behaviorally or chemically caused and does it involve multiple events?
- Are the sources of infection from inapparent sources?
- Is there a vector or animal reservoir involved?

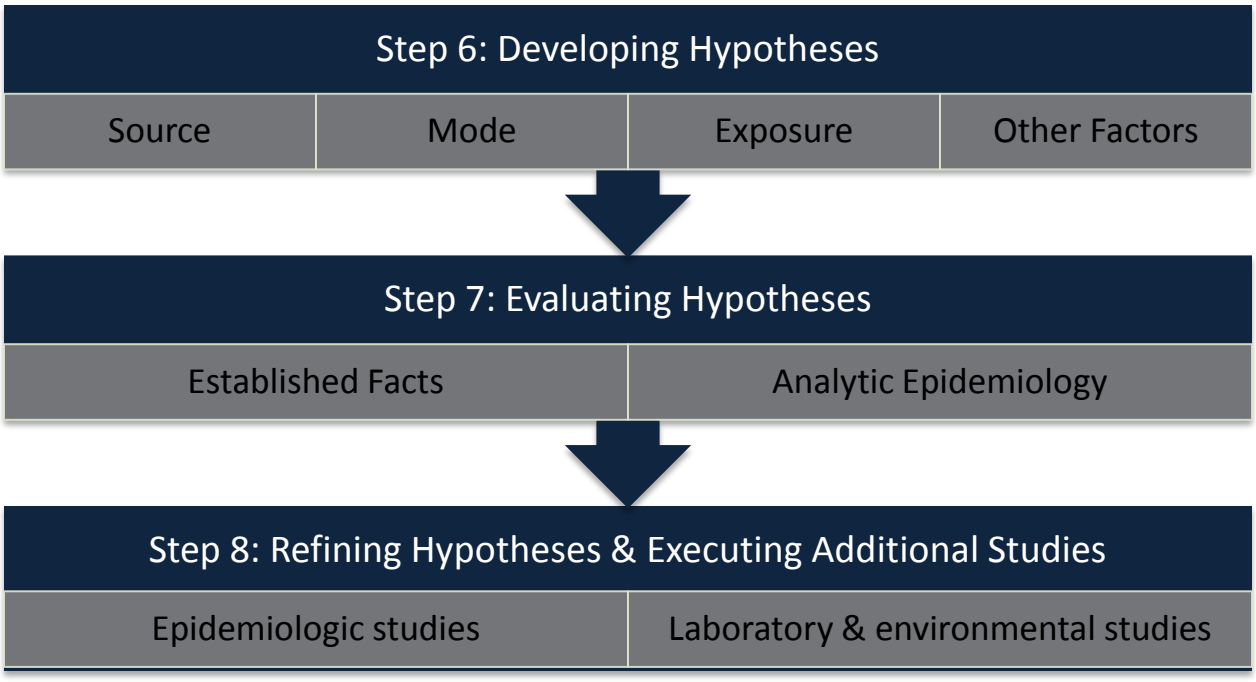
DURATION OF AN EPIDEMIC:

- ✓ **The number of susceptible persons who are exposed to a source of infection and become infected.**
- ✓ **Period of time over which susceptible persons are exposed to the source.**
- ✓ **Minimum and maximum incubation periods for the disease.**

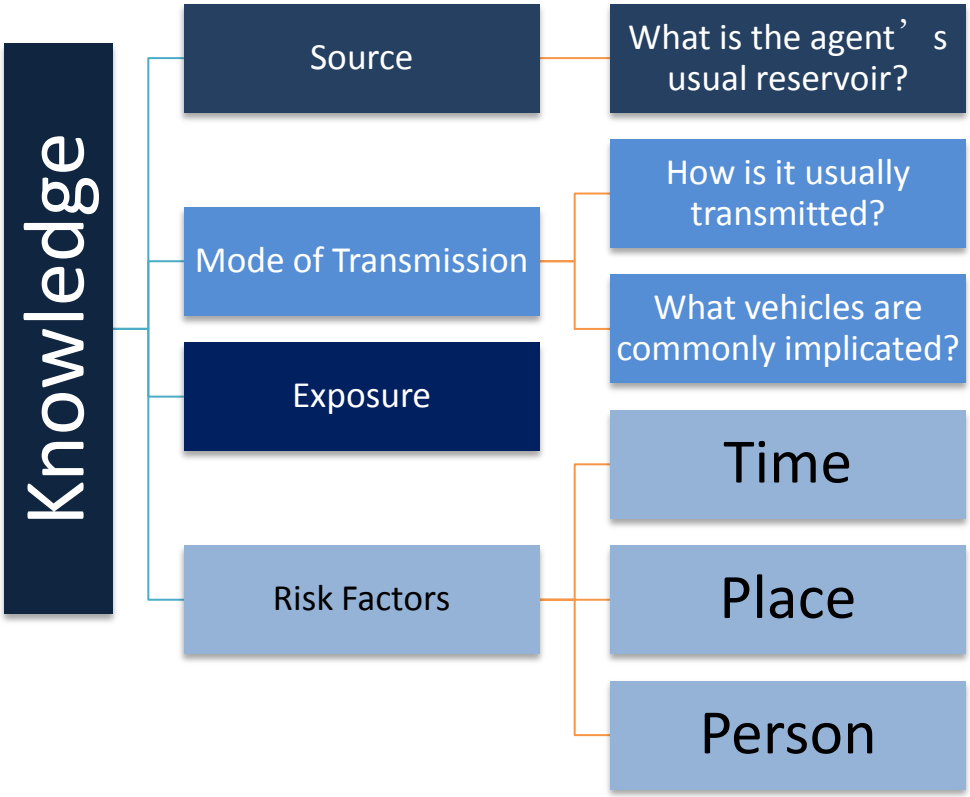
FIGURE 1

Influenza-like illness (ILI) incidence (cases per 100,000 population) reported by the national influenza sentinel surveillance systems in Denmark, Hungary, Portugal, Romania, and Spain, influenza season 2008-9*





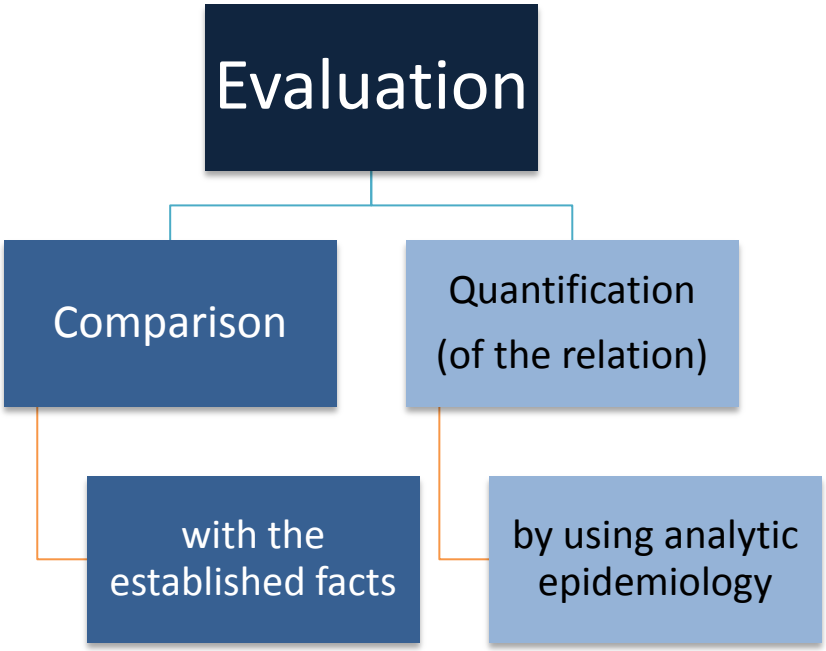
STEP 6: HYPOTHESES DEVELOPMENT



STEP 6: HYPOTHESES DEVELOPMENT

- Another useful way you can generate hypotheses is to talk to a few of the case-patients.
- In addition, investigators have sometimes found it useful to visit the homes of case-patients and look through their refrigerators and shelves for clues.

Step 7: Evaluating Hypotheses



WHICH ONE TO USE?

Comparison:

When the clinical, laboratory, environmental, and/or epidemiologic evidence so obviously supports the hypotheses that formal hypothesis testing is unnecessarily

Quantification

When the circumstances are not as straightforward; in those instances, you should use analytic epidemiology to test your hypotheses. The key feature of analytic epidemiology is a *comparison* group.

Note: The key feature of analytic epidemiology is a comparison group. The comparison group allows epidemiologists to compare the **observed** pattern among case-patients or a group of exposed persons with the **expected** pattern among non-cases or unexposed persons.

Analytic Epidemiology

Retrospective Cohort Study

- Study of choice for an outbreak in a small, well-defined population (e.g. Wedding)
- Exposure/Outcome of each member of the cohort

Calculate Attack Rates and Relative Risk (Risk Ratio)

Case – Control Study

- The population is not well defined (e.g. A city)
- The investigator asks both case-patients and a comparison group of persons without disease ("controls") about their exposures
- Calculate Odds Ratio

RETROSPECTIVE COHORT

FOOD	ATE			DID NOT EAT			
	Ill	well	AR	Ill	well	AR	RR
meat	29	17	63	17	12	59	
spinach	26	17	60	20	12	62	
potato	23	14	62	23	14	62	
salad	13	11	54	28	19	60	
Ice cream	43	11	80	3	18	14	

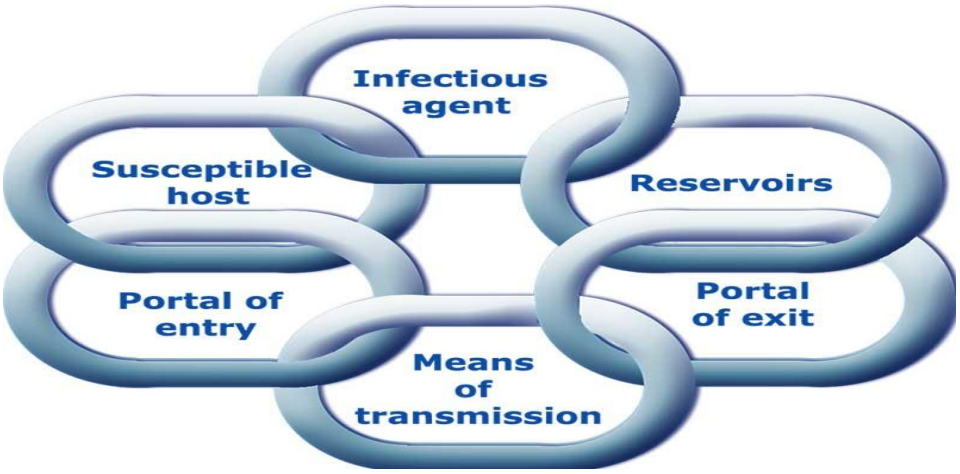
Exposure		Case	Control	Total
Ate at restaurant A	Yes	30	36	66
	No	10	70	80
Total		40	106	146

STEP 8: REFINING HYPOTHESES & EXECUTING ADDITIONAL STUDIES

- Epidemiologic studies
- Laboratory and environmental studies

Step 9: Implementing Control and Prevention Measures

Chain of Infection



An outbreak might be controlled by destroying contaminated foods, sterilizing contaminated water, or destroying mosquito breeding sites. An infectious food handler could be removed from the job and treated.

In other situations, control measures might be aimed at interrupting transmission or exposure – such as having nursing home residents with a particular infection "cohorted," or put together in a separate area to prevent transmission to others; or instructing persons wishing to reduce their risk of acquiring Lyme disease to avoid wooded areas or to wear insect repellent and protective clothing.

In some outbreaks, control measures might be directed at reducing the susceptibility of the host. Examples: Immunization against rubella and malaria as chemoprophylaxis for travelers.

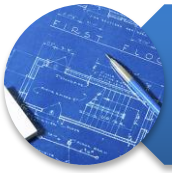
Step 10: Communicating the Findings

Oral Report	Written Report

WHAT TO INCLUDE IN THE REPORT?

- Summarize relevant data, methods of collection, analyses performed and interpretations.
- Describe preventive and control measures implemented
- Describe effectiveness of control measures
- Describe other impacts relevant to prevention and control.
- Make recommendations regarding future surveillance and control.
- Distribute report to others in disease control programs.

IMPORTANCE OF THE REPORT



Blueprint for Action

Legal Record

Reference for Future Situations

contributing to the knowledge base of epidemiology and public health.

SOME INVESTIGATIVE QUESTIONS:

- In whom (which groups) is the disease present?
- In whom (which groups) is the disease absent?
- What are the sick people doing that the healthy people are not?
- What are the healthy people doing that the sick people are not?
- What are the healthy people not doing that the sick people are doing?
- What are the sick people not doing that the health people are doing?
- Does the disease cluster by time, and place?
- What risk factors are present in people with the condition?
- What risk factors are absent in persons who do not have the condition?
- What risk factors are absent in persons with the condition?
- What exposures are present or lacking in persons with and without the disease or condition?

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9. Implement control and prevention measures
10. Communicate findings

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