DISEASE DETECTIVES – PRACTICE ACTIVITIES

Each practice activity will contain some background information followed by a task or series of tasks for the students to do. The **answers** to the tasks will be on the page following each practice activity. The practice activities will follow the outline of the Investigation Process given below.

Comparing the Scientific Method to 10 Steps in Outbreak Investigation

- Obtain Background Information **(Steps 1- 3)**
  - **Basic Terminology**
  - **Collecting Information about the Outbreak**

- Define the Problem **(Step 4-5)**
  - **Time/Place/Person Triad**
  - **Case Definition**
  - **Epi Curve**
  - **Line Listing of Cases**
  - **Identify specific cases as confirmed, probable, or possible**

- Formulate Hypothesis **(Step 6)**
  - **Chain of Infection**
  - **Agent/Host/Environment Triad**

- Develop a Study to Test the Hypothesis **(Step 7)**
  - **Cohort Study -** Based upon ***exposure status*** whether or not they have outcome (illness); used with a small well-defined population and moves forward from exposure.
  - **Case-Control Study -** Works ***backward from effect or illness*** to suspected

- Collect Data and Observations **(Step 7)**
  - **2X2 Table for Data**

- Evaluate Results **(Step 7)**
  - **Cohort Study – Attack Rate and Relative Risk**
  - **Case-Control Study – Odds Ratio**
  - **Incident Proportion (also known as attack rate)**

- Determine if Hypothesis is true/modify **(Step 8)**
  - **Must have lab verification**
  - **Begin treatment as soon as possible**

- Formulate Conclusions **(Step 9)**
  - **Must have a cause/effect relationship and make biological sense.**

- Report Results **(Step 10)**

Practice Activity - Background Information

Task: Match the Basic Term in Column A with the Meaning of the Term in Column B

	Column A	Column B
_____	**1. Outbreak**	**A.** compare people with and without exposures to see what happens to each
_____	**2. Surveillance**	**B.** an aggregation of cases over a particular period closely grouped in time and space, *regardless of whether the number is more than the expected number*
_____	**3. Pandemic**	**C.** compare people with and without disease to find common exposures
_____	**4. Vector**	**D.** a person or animal that harbors the infectious agent for a disease and can transmit it to others, but does not demonstrate signs of the disease
_____	**5. Cohort**	**E.** large numbers of people over a wide geographical area affected
_____	**6. Risk**	**F.** the probability that an individual will be affected by, or die from, an illness or injury within a stated time or age span.
_____	**7. Cluster**	**G.** more cases of a particular disease than expected in a given area or among a specialized group of people over a particular period of time
_____	**8. Carrier**	**H.** the systematic and ongoing collection, analysis, interpretation, and dissemination of health data
_____	**9. Epidemic**	**I.** an *epidemic* occurring over several countries or continents and affected a large *proportion* of the population
_____	**10. Case-control**	**J.** an animal that transmits disease

Task: What types of information should be acquired by a doctor in order to diagnose an illness in an individual and how does it compare to what disease detectives must acquire in order to identify an outbreak?

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For both an individual (case) and each case in an outbreak, it is important to examine the medical history of each individual, the symptoms of the illness, a time frame of when the symptoms began, the type of exposure the individual experienced, and some basic tests as temperature, blood pressure, respiration rate in attempting to make a diagnosis. Further tests as blood tests or cultures may be also needed.

Practice Activity – Case Definition

An outbreak is defined in terms of the Time/Place/Person Triad

TIME - Epidemic Curve or Epi curve (Begin early & update often) – a histogram showing the course of the disease or outbreak to identify the source of the exposure (x axis=units of time equal to 1/4 to 1/3 incubation time and y axis = # of cases) Note: a single point or source will have only one peak, a plateau will show a continuous common source, several uniform peaks will indicate a propagated outbreak spread from person to person

PLACE – **geographic extent plus spot map of cases** to identify groups specific to a location or environmental factors

PERSON–identify the affected population by type of person or by exposures as age, sex, high risk exposure as with AIDS – can be done with organized by using a **line listing**.

CASE DEFINITION - has 4 components and summarizes the time/place/person triad

1. clinical information about the disease,
2. characteristics about the people who are affected,
3. information about the location or place, and
4. a specification of time during which the outbreak occurred

Task: Using the information provided about an outbreak, compose a case definition.

400 people attended a special awards dinner in Acme on June 29, 2001. A half of the people who attended the dinner became ill. The individuals had symptoms including nausea, vomiting, cramps, and diarrhea. Many of the ill individuals were hospitalized overnight.

Case Definition:

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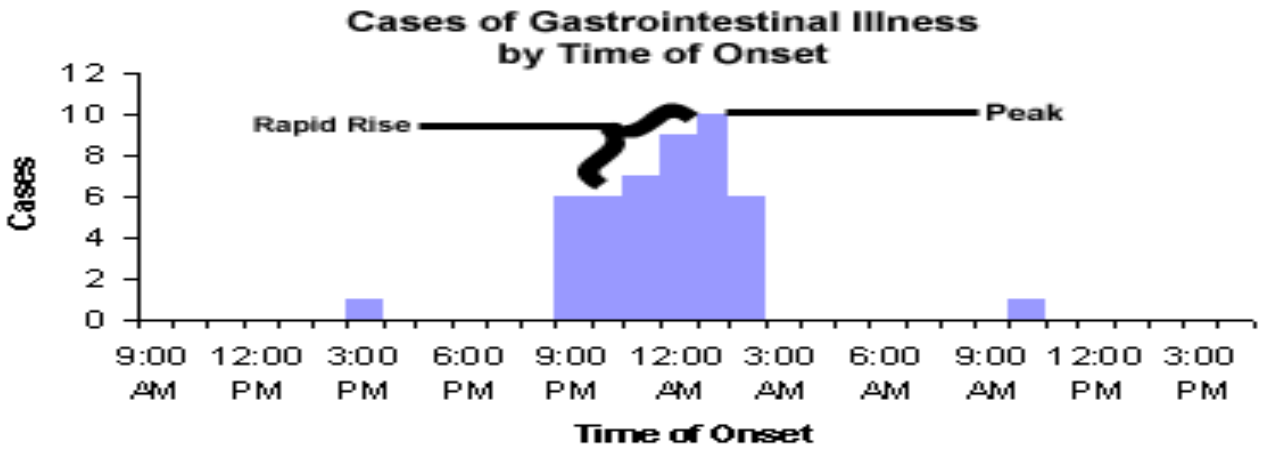
Case Definition: the onset of some combination gastrointestinal symptoms (e.g.,nausea, vomiting, diarrhea, and cramps) in a person attending the Awards Dinner in Acme on June 29, 2010.

Practice Activity - Epi Curve - An epi-curve is a histogram that shows the course of an outbreak by plotting the number of cases of a condition according to the time of onset.

Types of Epi Curves:

1. **Point source** epidemics occur when persons are exposed to the same exposure over a limited, well define period of time. The shape of the curve commonly rises rapidly and contains a definite peak, followed by a gradual decline.
2. **Continuous common source** epidemics occur when the 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.
3. **Propagated (progressive source)** epidemics occur when a case of disease serves later as a source of infection for subsequent cases and those subsequent cases, in turn, serve as sources for later cases. The shape of this 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 those susceptible is exhausted or control measures are implemented.

Task – Examine the following epi curve and answer the questions.



1. What is the independent Variable? How is it measured?

2. What is the dependent Variable? How is it measured?

3. How many cases were present at the peak?

4. When was the onset of the first case?

5. What type of Epi Curve does this Epi Curve Represent? Why?

<u>Practice Activity - Epi Curve</u> - An epidemic curve or epi-curve is a histogram that shows the course of an outbreak by plotting the number of cases of a condition according to the time of onset.

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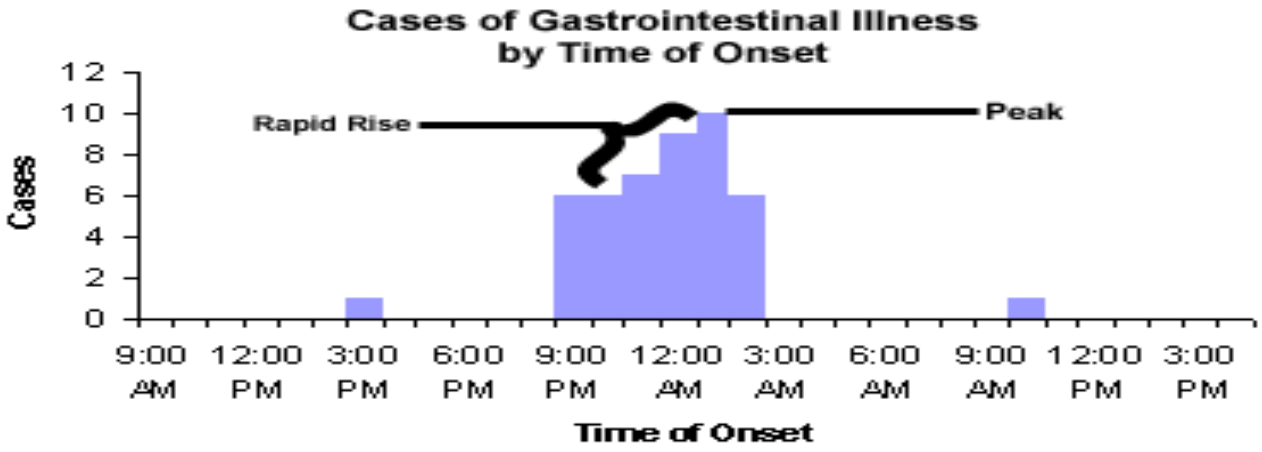

1. What is the independent Variable? How is it measured?
   Time of onset **by the hour**
2. What is the dependent Variable? How is it measured
   Cases **number of cases**
3. How many cases were present at the peak?
   10 cases
4. When was the onset of the first case?
   3 PM
5. What type of Epi Curve does this Epi Curve Represent? Why?
   Point Source – rapid ruse and only one peak

Practice Activity - Line Listing

***Case Definition for Trichinosis* - A disease caused by ingestion of *Trichinella* larvae usually caused by ingesting undercooked contaminated pork.**

Acute onset of at least three of the following four features: myalgia (muscle pain), fever, facial edema, or eosinophil count greater than 500/mm3

ID#	Name	Myalgias	Fever	Edema	Eosinophil Count	Diagnosis	Confirmation	Case Classification
1	Anderson	yes	yes	no	495	trichinosis	yes	
2	Jones	yes	yes	yes	pending	possible	pending	
3	Kelly	yes	yes	no	1,100	possible	pending	
4	Smith	yes	yes	no	1,500	possible	pending	
5	Long	no	yes	no	Not done	Not done	None done	

Case classification

Suspected (Possible): Any febrile illness (with a fever) accompanied by rash
Probable: A case that meets the clinical case definition, has noncontributory or no serologic or virologic testing, and is not epidemiologically linked to a confirmed case
Confirmed: A case that is laboratory confirmed or that meets the clinical case definition and is epidemiologically linked to a confirmed case. (A laboratory-confirmed case does not need to meet the clinical case definition.)

Task – for each individual on the line listing, indicate how the case should be classified.

1. Anderson
2. Jones -
3. Kelly -
4. Smith -
5. Long –

Task - Analysis of information.

1. What type of organism is ***Trichinella*** and how does it get into the pork?

2. What can be done to prevent this type of outbreak?

Practice Activity- Line Listing

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1. Anderson – **Confirmed**
2. Jones - **Probable**
3. Kelly - **Probable**
4. Smith - **Probable**
5. Long – **Possible**

Task - Analysis of information.

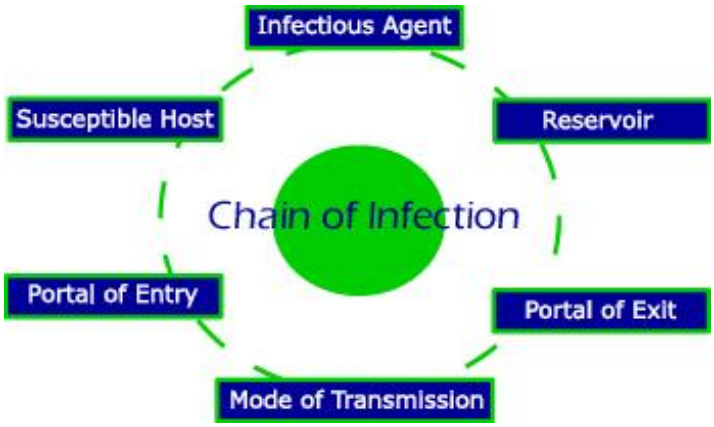
1. What type of organism is ***Trichinella*** and how does it get into the pork?

   It is a parasitic round worm that was ingested by the pig and the larva are in the pig's muscles which we eat as pork.

2. What can be done to prevent this type of outbreak?

   Thoroughly cook the pork to kill any larva that might be present.

Practice Activity - Chain of Infection – Each link in the circle must be present and in sequence for an infection to occur.



Task: Match the Component of the Chain of Infection in Column A with the Explanation of the Component in Column B.

	Column A – Components	Column B – Explanations
_____	**1. Agent**	**A.** a place of exit providing a way for an agent to leave the reservoir
_____	**2. Reservoir**	**B.** method of transfer by which the organism moves or is carried from one place to another
_____	**3. Portal of exit**	**C.** a person who cannot resist an microorganism invading the body, multiplying and resulting in infection.
_____	**4. Mode of transmission**	**D.** a microbial organism with the ability to cause disease
_____	**5. Portal of Entry**	**E.** an opening allowing the microorganism to enter the host
_____	**6. Susceptible host**	**F.** a place where agents can thrive and reproduce

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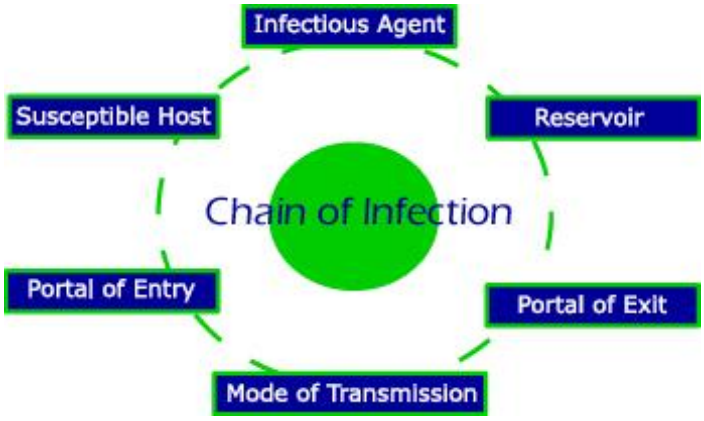

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	Column A – Components	Column B – Explanations
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F	2. **Reservoir**	**B.** method of transfer by which the organism moves or is carried from one place to another
A	3. **Portal of exit**	**C**. a person who cannot resist an microorganism invading the body, multiplying and resulting in infection.
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Practice Activity - Defining the Hypothesis:

Agent/Host/Environment Triad consists of:

An external agent
A susceptible host
An environment that brings the host and agent together so that disease occurs.

Task Questions:

1. What type of organisms can act as an external agent to cause infection?

2. What are the characteristics of a susceptible host?

3. What type of environments can bring the host and agent together?

4. What types of organisms can act as vectors for infectious microbes?

5. What things could be done to stop the disease from occurring?

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Task Questions:

1. What type of organisms can act as an external agent to cause infection?
   bacteria, viruses, parasites as parasitic worms, protozoa, natural toxins, and other pathogenic agents as prions

2. What are the characteristics of a susceptible host?
   a person who cannot resist an microorganism invading the body, multiplying and resulting in infection. The young, the elderly, and people with weakened immune systems may be more susceptible and the normal individual.

3. What type of environments can bring the host and agent together?
   An environment that brings the host and agent together, so that disease occurs. It might involve such things as contaminated food that is ingested, an environment that allow a vector to introduce the agent into the host as a mosquito bite, air that allow an agent to be inhaled by a host or agents spread by contact between two people.

4. What types of organisms can act as vectors for infectious microbes?
   Insects or other arthropods such as mosquitos, ticks, fleas, tsetse flies, and sand flies.

5. What things could be done to stop the disease from occurring?
   The task is to break the triad and keep the agent from getting to the host and destroy the agent if it is already in the host.

   Some of the approaches might include:
   - **Eliminating the agent by such things as antibiotic or other medications**
   - **Strengthening the immune system of the host by immunizations**
   - **Eliminating the possible vectors – as reducing the mosquito populations**
   - **Preventing contamination as by proper cooking handling, cooking, and storage of food**
   - **Isolating infectious individuals**
   - **Healthy habits as hand washing, proper sleep, diet, and exercise**

Practice Activity – Cohort Study

Experimental and Control Groups are needed for all studies used to test a hypothesis.

Cohort Study – Based upon ***exposure status*** whether or not they have outcome (illness); used with a small well-defined population and moves forward from exposure.
Both groups have a known exposure and are checked for future outcomes or illness.

2 X 2 Table

	Disease Yes	Disease No
Exposed	a	b
Unexposed	c	d

Attack rate – the rate that a group experienced an outcome or illness
Attack Rate = number sick ÷ total in that group (usually expressed as a percent)
exposed = a ÷ (a+b)
unexposed = c ÷ (c + d)
Relative risk = [a ÷ (a+b)] / [c ÷ (c+d)]

Task: Examine the following case and answer the questions.
Cyclosporiasis is an infection with the protozoan *Cyclospora cayetanensis*, a pathogen transmitted by feces or feces-contaminated fresh produce and water.

Within 10 days after attending a June wedding, an outbreak of cyclosporiasis occurred among attendees. Of the 83 guests and wedding party members, 79 were interviewed; 54 of the 79 met the case definition. The following two-by-two table shows consumption of wedding cake (that had raspberry filling) and illness status.

	Disease Yes	Disease No	Totals
Exposed –ate cake	(a) 50	(b) 3	53
Unexposed - did not eat cake	(c) 4	(d) 52	26
Totals	54	25	79

Source: Ho AY, Lopez AS, Eberhart MG, et al. Outbreak of cyclosporiasis associated with imported raspberries, Philadelphia, Pennsylvania, 2000. Emerg Infect Dis 2002;l8:783–6.

1. Which group is the experimental group for this outbreak?

2. What is the control group for this outbreak?

3. Determine the Attack Rate for the Exposed Group who ate the wedding cake.

4. Determine the Attack Rate for the Unexposed group who did not eat the wedding cake.

5. Determine the Relative Risk for this outbreak.

6. Interpretation of Results: - Explain what the Relative Risk means?

7. What caused the contamination of the wedding cake?

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1. Which group is the experimental group for this outbreak?

   Those that ate the wedding cake – exposed group

2. What is the control group for this outbreak?

   Those that did not eat the wedding cake – unexposed group

3. Determine the Attack Rate for the Exposed Group who ate the wedding cake.

   Attack Rate for the Exposed Group = a ÷ (a+b) = 50/53 = 94%

4. Determine the Attack Rate for the Unexposed group who did not eat the wedding cake.

   Attack Rate for the Unexposed Group = c ÷ (c + d) = 4/26 = 15%

5. Determine the Relative Risk for this outbreak.

   Relative Risk = [a ÷ (a+b)] / [c ÷ (c+d)] = 6

6. Interpretation of Results: - Explain what the Relative Risk means?

   A person who ate the wedding cake was 6 times more likely to develop cyclosporiasis than one that did not eat the cake.

7. What caused the contamination of the wedding cake?

   Contamination of the imported raspberries in the cake's filling

Practice Activity - Case-Control Study

It works ***backward from effect or illness*** to suspected cause. The Control group is a selected group who has similar characteristics to the sick group but is not ill. They are then checked for similar exposures.

2 X 2 Table

	Case Patients	Control Patients
Yes	a	b
No	c	d

Odds Ratio is calculated to evaluate the possible agents & vehicles of transmission.

$$\textit{Odds Ratio} = \frac{\text{Odds of exposure in cases}}{\text{Odds of exposure in controls}} = \frac{a/c}{b/d} = \frac{ad}{bc}$$

Task: Examine the following case and answer the questions.

Problem: An outbreak of aflatoxin poisoning related to maize or corn in Africa. Aflatoxin is a toxin produced by the **fungus *Aspergillus*** which can contaminate food. Investigators conducted a case-control study with 40 case-patients and 80 controls. Among the 40 poisoning victims, 32 reported storing their maize inside rather than outside. Among the 80 controls, 20 stored their maize inside.

2 X 2 Table

	Case Patients	Control Patients	Total
Yes	(a) 32	(b) 20	52
No	(c) 8	(d) 60	68
Totals	40	80	120

1. Determine the Odds Ratio for this Outbreak.

2. Interpretation of Results: Explain what the odds ratio means.

3. Possible Explanation: What might account for the reason contamination is more likely in the maize stored inside?

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Totals	40	80	120

1. Determine the Odds Ratio for this Outbreak.

   The odds ratio is calculated as ad/bc, or (32 x 60) / (8 x 20), which equals 1,920 / 160 or 12.0.

2. Interpretation of Results: Explain what the odds ratio means.

   A person who stores their maize inside is 12 times more likely to develop aflatoxin poisoning than a person who stores their maize outside.

3. Possible Explanation: What might account for the reason contamination is more likely in the maize stored inside?

   The environment inside may be more moist and more conducive to mold growth.

Practice Activity – Validation of Results and Drawing Conclusions

Validation of Results

Task: Attack Rate or Odds Ratio will tell you the strength of association for the cause/effect relationship, but what else is needed to validate a hypothesis?

Why is it so important to begin treatment as soon as adequate information is available even if the results have not yet been validated?

Drawing Conclusions

Task: List the criteria disease detectives use for determining causality when conducting investigations- which is also the criteria for drawing conclusions.

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LAB VERIFICATION NEEDED TO VALIDATE A HYPOTHESIS,

Why is it so important to begin treatment as soon as adequate information is available even if the result have not yet been validated?

People are ill and need to be treated as soon as possible. As with your visit to the doctor, treatment is started as soon as possible even though it may have to be altered or modified as new evidence is collected.

Drawing Conclusions

Task: List the criteria disease detectives use for determining causality when conducting investigations. - which is also the criteria for drawing conclusions.

1. **Temporality – cause/exposure must precede effect/outcome**
2. **Consistency – observation of association must be repeatable in different populations at different times**
3. **Coherence, 1-1 relationship – exposure is always associated with outcome/ outcome is always caused by the specific exposure**
4. **Strength of association – relationship is clear and risk estimate is high**
5. **Biological plausibility – biological explanation makes sense**
6. **Dose/response (biologic gradient) – increasing risk is associated with increasing exposure**
7. **Specificity – a single cause produces a single effect**
8. **Experimental evidence to prove the hypothesis**
9. **Alternate Explanations – consideration of multiple hypotheses before making conclusions about whether association is causal or not**