2009 DISEASE DETECTIVES (B&C)
TRAINING HANDOUT
by Karen L. Lancour

Event Format :

- Format and material of the Division B and C event is similar except that the level of reasoning and math skills should be consistent with the grade level.
- Differences between the two levels should be reflected in both the type of questions asked and the scoring rubrics. **2009 emphasis will be on public health problems related to population growth.**
- A non-programmable calculator is allowed but no resources are permitted.
- Format and material of the Division B and C event is similar except that the level of reasoning and math skills should be consistent with the grade level.
- Differences between the two levels should be reflected in both the type of questions asked and the scoring rubrics.

Types of Knowledge

- Definitions of basic epidemiologic terms
- Categories of disease causing agents
- Modes of disease spread
- Triads of analysis (e.g., person/place/time & agent/host/environment
- The basis for taking action to control and prevent the spread of disease

Epidemiology

- Studies health of populations instead of individuals
- Uses the scientific method – 10 step method of investigating outbreaks
- Studies the distribution and determinants of disease in human populations
- Attempts to prevent and control those diseases
- Health-related events:
    - chronic diseases
    - environmental problems
    - behavioral problems
    - injuries
    - infectious diseases

2009 Emphasis - Public Health Concerns Related to Population Growth:

- Water Quality, Water Pollution, Water Demands
- Sanitation Needs
- Growth of Slums and Household Environment
- Environmental Degradation
- Air Pollution
- Infectious Disease Outbreaks
- Rapid Spread of Disease via Public Transportation and Air Travel
- Food Quality and Food Contamination
- Lack of food in poor nations vs. unhealthy fast food and drinks in technological societies
- Availability of health care for the poor and the aged
- People moving into uninhabited areas = new pathogens
  as Lyme Disease and Ebola

Basic Epidemiology Terms

Outbreak – (localized epidemic) – 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.

Epidemic – large numbers of people over a wide geographic area affected.

Cluster –an aggregation of cases over a particular period esp. cancer & birth defects closely grouped in time and space regardless of whether the number is more than the expected number. (often the expected number of cases is not known.)

pandemic -An epidemic occurring over a very wide area (several countries or continents) and usually affecting a large proportion of the population.

risk - The probability that an individual will be affected by, or die from, an illness or injury within a stated time or age span.

vector - an animate intermediary in the indirect transmission of an agent that carries the agent from a reservoir to a susceptible host. An organism that transmits the infection as a mosquito transmits the malaria protozoans.

fomite - a physical object that serves to transmit an infectious agent from person to person. A comb infested with one or more head lice would be a fomite or the dust particles containing infectious cold virus that remain after droplets of infected saliva are coughed into the air.

zoonosis - An infectious disease that is transmissible from animals to humans.

surveillance - The systematic, ongoing collection, analysis, interpretation, and dissemination of health data. The purpose of public health surveillance is to gain knowledge of the patterns of disease, injury, and other health problems in a community so that we can work toward controlling and preventing them.

Scientific Method as related to Disease Detectives

Compare Scientific Method to 10 Steps in Outbreak Investigation

- Obtain Background Information **(Steps 1- 3)**
- Define the Problem **(Step 4-5)**
- Formulate Hypothesis **(Step 6)**
- Develop a Study to Test the Hypothesis **(Step 7)**
- Collect Data and Observations **(Step 7)**
- Evaluate Results **(Step 7)**
- Determine if Hypothesis is true/modify **(Step 8)**
- Formulate Conclusions **(Step 9)**
- Report Results **(Step 10)**

10 STEPS OF AN OUTBREAK INVESTIGATION

Field investigation of disease or health condition

- Implement control as soon as the source & mode are known!!!!

This is a conceptual order – steps may be done at the same time

Step 1: Prepare for Field Work

1. Research, supplies & equipment – research the disease or situation and gather needed supplies & equipment to conduct the investigation
2. Administrative arrangements – make official administrative and personal travel arrangements
3. Local contacts - follow protocol and contact all parties to determine roles & local contacts

Step 2: Establish the Existence of an Outbreak – consider severity, potential for spread, public concern, and availability of resources

1. Expected # of cases for area – use records as health dept., hospital records, death records, physician records, doctor survey to determine expected # for the area in a given time
2. Other factors in play – numbers may exceed normal due to factors such as better reporting, seasonal fluctuations, population changes

Step 3: Verify the Diagnosis

1. Proper diagnosis- verify the procedures used to diagnose the problem and check methods used for identifying infectious and toxic chemical agents
2. Not lab error – be sure that the increase number of cases are not due to experimental error
3. Commonality – interview several persons who became ill to gain insight concerning possible cause, source, and spread of disease or problem

Step 4: Define and Identify Cases – case definition and line listing

1. Case definition – establish with the 4 components or standard criteria for determining who has the disease or condition
    a. Clinical information – about the disease or condition
    b. Characteristics- of the affected people
    c. Location or place- as specific as possible as restaurant, county, or several specific areas
    d. Time sequence- specific time during which the outbreak or condition occurred
2. Identification of specific cases – kind & number – count specific cases
    a. Confirmed – have diagnosis with case definition plus lab verification
    b. Probable – many factors point to diagnosis but may lack lab verification
    c. Possible – some factors point to diagnosis
    Note: Initial reports may be only a small sampling of the total problem. Be sure to expand search to determine the true size and extent of the problem.
3. Line Listing – chart of specific cases including information about each case
    a. Identifying information- ID or case # - left column + name or initials
    b. Clinical information – diagnosis, symptoms, lab results, hospital – death?
    c. Descriptive: time – date & time of onset + date of report
    d. Descriptive: person – age, sex, occupation, other characteristics
    e. Descriptive: place – street, city or county + specific site
    f. Risk factors & possible causes – specific to situation (disease) and outbreak setting

Sample Line Listing from six case report forms on a wedding reception outbreak

ID #	Initials	Date Onset	Diagnosis	How ınfirmed	Age	Sex	County	Physician	Cleveland-ɛKay ɛdding
1	KR	7/23	probable trichinosis	Not done	29	M	Columbia	Goodman	Yes
2	DM	7/27	trichinosis	Biopsy	33	M	Columbia	Baker	Yes
3	JG	8/14	probable trichinosis	Not done	26	M	Columbia	Gibbs	Yes
4	RD	7/25	trichinosis	Serologia	45	M	King	Webster	Yes
5	NT	8/4	trichinosis	Not done	27	F	Columbia	Stanley	Yes
6	AM	8/11	R/Otrichinosis	Pending	54	F	Clayton	Mason	Yes

Step 5: Describe and Orient the Data in Terms of <u>Time, Place and Person</u> – Descriptive Epidemiology

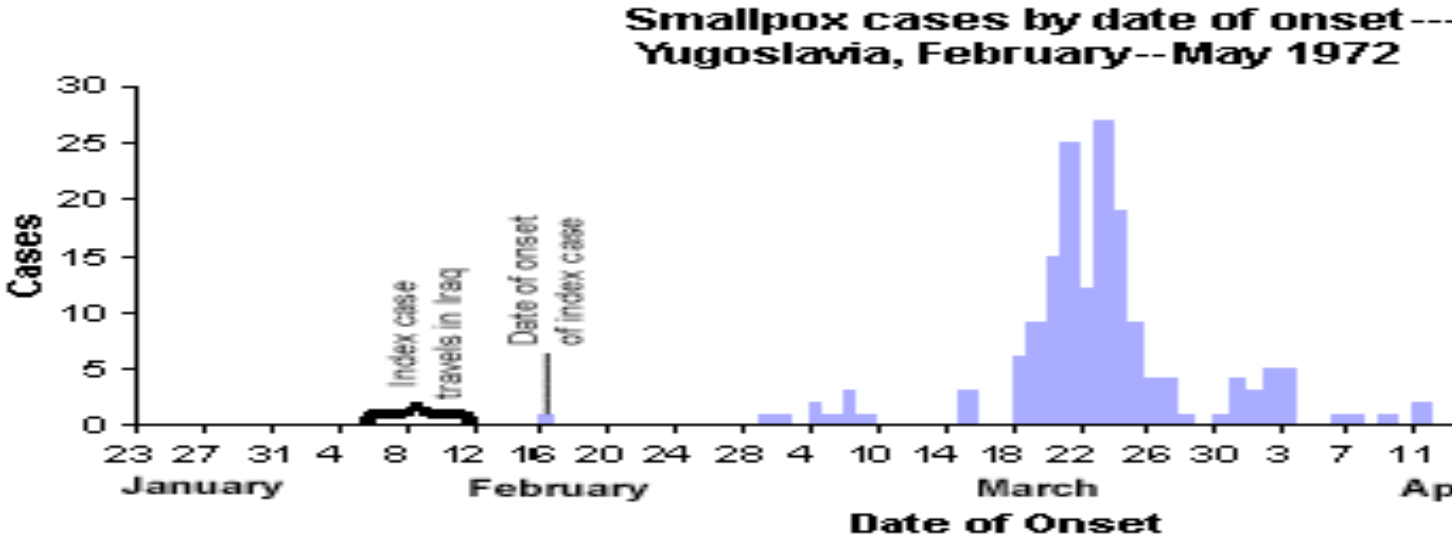
1. <u>Time, Place and Person</u> – describes disease or health situation

TIME - <u>Epidemic Curve or Epi curve</u> (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

Sample EPI or Epidemic Curve



2. <u>Types of Descriptive Studies</u> – Study the distribution of a problem by cases or outcome, frequency in population, exposure, time pattern or environmental factor (Studies without a control group can be used for descriptive purposes!)
   a. <u>Case report</u>/<u>case series</u> – case report = detail report of a single patient from one or more doctors while case series = characteristics of several patients
   b. <u>Correlative studies</u> – correlates general characteristics of the population with health problem frequency with several groups during the same period of time

Time series analysis – correlate within the same population at different point in time
Ecologic relations – correlate relative to specific ecologic factors as diet

c. Cross sectional - a survey of a population where participants are selected irrespective of exposure or disease status

Step 6: Develop Hypotheses (Agent/host/environment triad) = chain of transmission

1. Agent /host /environment = agent capable of causing disease & its source + host or persons susceptible to agent + environment allowing them to get together
   Infectious Groups: viruses, bacteria, protistans (protozoa), fungi, animals **(**worms)
2. Testable – hypothesis must be in a form that is testable
3. Current knowledge & background – it should be based upon current knowledge and be updated or modified as new information is uncovered!!!

Step 7: Evaluate Hypotheses – Analytical studies ** Must have a control group**

1. Compare with established fact – these are used when evidence is strong and clear cut
2. Observational Studies: (Study determinants of health problems – how & why)

a. **Cohort** – 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.
retrospective:(historic cohort) starts at exposure in past & moves forward to outcome
prospective: starts a present exposure and moves forward in time to outcome

(Calculations = attack rate and relative risk)

Sample using 2 X 2 table: 400 people attended a special awards dinner.
Some persons became ill. The suspected culprit was the potato salad.
The population at the dinner was then surveyed to determine who became ill.

	Disease Yes	**Disease No**
Exposed (Ate salad)	150 **(a)**	30 **(b)**
Unexposed (no salad)	50 **(c)**	170 **(d)**

Attack rate – the rate that a group experienced an outcome or illness
= number sick ÷ total in that group
(Look for high attack rate in exposed & low rate in unexposed)
exposed = a ÷ (a+b) = 150 ÷ 180 = 80%
unexposed = c ÷ (c + d) = 50 ÷ 220 = 20%
Relative risk = [a ÷ (a+b)] / [c ÷ (c+d)] = 80% ÷ 20% = 4

1. Relative risk estimates the extent of the association between an exposure and a disease. It estimates the likelihood of developing the disease in the exposed group as compared to the unexposed group.
2. A relative risk = 1.0 indicates that the incidence rates of disease in the exposed group is equal to the incidence rates in unexposed group. Therefore the data does not provide evidence for an association.
3. A relative risk >1.0 indicates a positive association or an increased risk. This risk increases in strength as the magnitude of the relative risk increases.
4. The data indicates a negative association or decreased risk (possible protective effect) if the relative risk is between 0 and 1.0. Relative risk is not expressed in negative numbers.

b. **Case-Control** - Works ***backward from effect or illness*** to suspected cause. 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. It is often hard to select the control group for this type of study.
Odds Ratio is calculated to evaluate the possible agents & vehicles of transmission.

Odds Ratio = Odds of exposure in cases / Odds of exposure in controls = a/c / b/d = ad / bc

a = # of case patients exposed **b** = # of control exposed
c = # of case patients unexposed **d** = # of control unexposed

Sample: Several patients were diagnosed with Hepatitis A. The local Restaurant A was thought to be the source of the infection. 40 case patients and a similar disease free group or control were contacted to determine if they **ate** at Restaurant A.

2 X 2 table of data:

	Case patients	**Controls**	**Total**
Yes	**a** = 30	**b** = 36	66
No	**c** = 10	**d** = 70	86
Total	40	106	146

The odds ratio for Restaurant A is thus 30 × 70 / 36 × 10 = 5.8. This means that people who ate at Restaurant A were 5.8 times more likely to develop hepatitis A than were people who did not eat there.

Step 8: Refine Hypotheses and Carry Out Additional Studies

1. No confirmation of hypothesis - where analytical studies do not confirm hypothesis May need to look for a new vehicle or mode of transmission
2. More specific – May need to be more specific in make up of case patients & controls
3. Verify with environmental/laboratory studies - verification with very control conditions is very important.

Step 9: Implement Control and Prevention Measures – as soon as possible!!

1. As soon as source is known – people are sick or hurting and need help; must know agent & source of agent + susceptibility of host+ chain of transmission
2. Aim at chain of agent-source-host – break the chain of transmission at any of its 3 points
3. May interrupt transmission or exposure – with vehicles as isolation
4. May reduce susceptibility – with immunization, legal issues and/or education

Step 10: Communicate Findings (see * on page 6 for conclusion criteria)**

1. Oral briefing – inform local health officials or other need-to-know groups as soon as information is available
2. Written report – usually done in scientific format for future reference, legal issues, and education

*****Criteria to Draw Conclusions about Cause and Effect Relations:**

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

Examples of types of performance indicators that could be used in Division B and C events at various levels of competition.

Competition Level	Division	
	Division B (Middle School)	Division C (High School)
Regional/State	List and recognize examples of different modes of transmission Calculate health-related rates (attack, incidence, prevalence, case fatality) Calculate a simple relative risk and describe what it means Interpret epi curves, temporal patterns and other simple graphic presentations of health data.. List, discuss and recognize examples of disease causing agents (physical and biological) Demonstrate an understanding and ability to use terms such as endemic, epidemic and pandemic; population versus sample, association versus cause. Describe various types of prevention and control strategies (e.g. immunization, behavior change, etc) and situations where they might be used	Recognize differences between study designs. Calculate measures of risk (e.g. relative risk or odds ratio) when given a description of the study design Calculate measures based on data that is not given but that can be readily extracted. Recognize how gaps in information influence the ability to extend conclusions to the general population.
National	Understand how units affect the relative magnitude of a set of rates with different units. Calculate appropriate measures of risk when given the study design Complete tables when given all data needed to complete calculations. Propose a reasonable intervention to a public health problem. Recognize gaps in information	Recognize unmentioned factors that may influence results. Convert between rates with different basic units (e.g. incidence per 10000 persons/year to incidence per 100 persons/week). Propose a means to evaluate the effectiveness of an intervention or control program.

Sample Tasks: Develop sample problems for Outbreak Investigation relating to the current year topics and then follow the 10 steps for Investigation the Outbreak to solve the problem. Use the Sample Problem provided to help you get started.

Disease Detectives – Sample Problem From CDC

At least 70 people attending a national conference in a city in Texas became ill with what appeared to be food poisoning. Three hospitals in the area treated and released 48 attendees who complained of nausea and vomiting; others with similar symptoms were hospitalized overnight. A health official noted that all of the patients had eaten brunch or lunch at the same hotel.

The hotel's lunch menu included roast chicken, roast beef, and a vegetable pasta dish. Because some of the people who became ill were vegetarian, there was particular interest in determining whether the pasta dish might be contaminated. At the time of the report, health officials were still looking for the source of the outbreak. The hotel was cooperating in the investigation and had voluntarily halted food service for the time being.

Questions

1. Explain why you might consider this problem important enough to investigate. Give at least three reasons for investigating.

2. Briefly describe the initial steps that you would take in investigating this problem. Indicate the type of data needed to accomplish each step and give examples of sources of such data in a community.

3. Develop and specify probable hypotheses to explain the cause, source, and spread of the outbreak.

4. Describe approaches to testing alternative hypotheses.

5. Develop suitable recommendations and interventions for controlling the problem.

Disease Detectives – Sample Problem

Sample Problem: Answer Key

1. The problem appears serious because a large number of people attending the same event became ill with similar symptoms at the same time. Many of them were sick enough to need hospital care. Some of the reasons for investigating are to find out if a common infectious organism or toxic agent caused the illness, to prevent additional cases of illness from the same source, and to recommend ways of preventing the recurrence of this problem in another place or time.

2. **Step 1**: Confirm the diagnosis—you should first make certain that these people actually had gastroenteritis and that this report does not represent either a mistake in diagnosis or mass hysteria. Data Needs and Sources: You need to get diagnostic data from local doctors and hospital emergency room staff.

   Step 2: Confirm that an outbreak really occurred—you should show that the number of people with gastroenteritis in this group was higher than would normally be expected. Data Needs and Sources: You need to know how many people attended the meeting. Unfortunately, the press report does not give this information, but the hotel or the organization sponsoring the conference would be able to help.

   Step 3: Define and identify cases of illness—you will first need to develop a case definition using data on the symptoms, the time and place the illness occurred, and common characteristics of the people who were ill.

   Case Definition: "the onset of some combination of acute gastrointestinal symptoms (e.g., nausea, vomiting, diarrhea, and cramps) in a person attending the XYZ Conference held in Someplace, Texas, on June 4-6, 1998."

   Data Needs and Sources: To identify cases, you need to interview either all of the people attending the conference or a representative sample of those people. You might also interview hotel employees and food servers. You should be able to get addresses and telephone numbers for conference participants by asking the organizers for a copy of the master registration list. You would also need to contact area physicians, clinics, and hospital emergency rooms.

3. The news report stated that everyone who became ill had eaten brunch or lunch on Wednesday at the same hotel; that the menu included chicken, beef, and vegetable pasta; and that vegetarians were among those who became ill. Possible hypotheses are

   One or more of these food items was contaminated with a microorganism (bacteria or virus) or toxin that causes gastroenteritis. However, the newspaper account is probably incomplete, and beverages and other food items were probably served.

   If any of the foods or beverages are eventually proven to be contaminated, they would be considered a "common source" for the outbreak.

   It could be that none of the items served by the hotel over the lunch hour was contaminated and that people were exposed elsewhere. For example, those who became sick could have been together at a meeting someplace else where contaminated snacks and beverages were served during a break.

4. Two of the most important methods for testing hypotheses are cohort studies and case-control studies. Both use a comparison group to evaluate the relationships between different exposures and the risks of disease. The nature of the outbreak determines which of these studies is used.

Cohort studies are used for outbreaks in small, well-defined populations, for which a complete list of participants is available. In this type of study, groups of people who have been exposed to suspected risk factors are compared with groups who have not been exposed. For example, in the gastroenteritis outbreak described here, you could use a cohort study to examine the role of each food and beverage item by determining and then comparing the "relative risk" of illness for each item. The relative risk for each item is calculated by dividing the illness incidence (or "attack rate") among people who ate or drank the item by the incidence among people who did not.

Case-control studies compare people with a disease (case-patients) with a group of people without the disease (controls) and are used when the population is not well defined. In a case-control study, case-patients and controls are asked about their exposures. You compare the proportion of cases and controls exposed to each risk factor and use these proportions to calculate an "odds ratio," which is a measure of the relation between the exposure and likelihood of disease.

5. In the outbreak described above, the decision to shut down the hotel's food service may have been based on preliminary findings of the investigation. Once the investigation pinpointed the source of the contaminated food, health officials might have included one or more of the following measures in their recommendations for food handlers:

    - Wash hands, knives, and cutting boards and other work surfaces after each handling of uncooked food.
    - Wash raw produce thoroughly before serving it or placing it on work surfaces for preparation.
    - Keep prepared produce refrigerated until served.
    - Keep uncooked meats separate from vegetables, cooked foods, and ready-to-eat foods.
    - Cook raw meat thoroughly.
    - Cook leftover foods or ready-to-eat foods until they are steaming hot.
    - Do not allow food workers to work when they are experiencing a gastrointestinal illness.