What is the root cause of this outbreak?

Introduction to Outbreak Investigation
Module 6 – Generating Hypotheses

Objectives

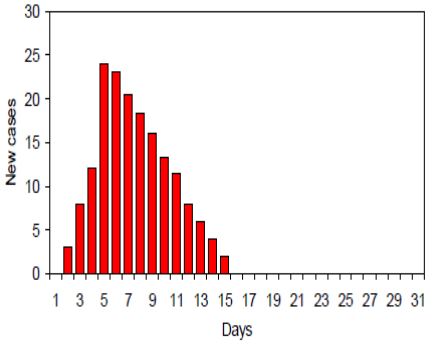
After completing this Lesson you should:

- Use “descriptive & analytical epidemiology” of outbreak to guide your hypothesis generation
- Review the literature, talk to experts, interview owners, and examine previous case histories before generating a hypothesis
- Know where to find the clues for determining 1) disease, 2) route of exposure, and 3) population at risk
- Know that your hypothesis is an educated guess…
  …based on available data…
  …that will generate further investigation and clarification

What is an outbreak? Quick review:

- An increase in the number of disease cases over and above an "expected" number per given place or time period
- In rare diseases, one case may be considered an outbreak
- Some reportable, highly contagious or damaging diseases may warrant an investigation by law
- Clusters are an aggregation of relatively uncommon events or diseases in space or time in amounts

  believed or perceived to be greater than could be expected by chance



How are outbreaks detected?

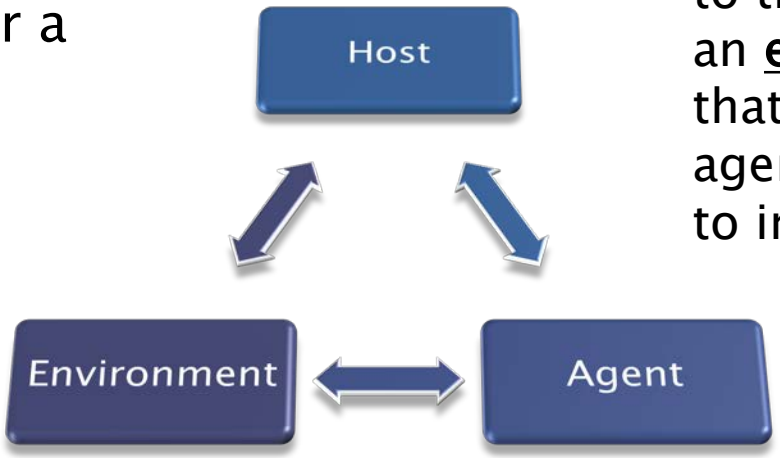
- Disease detection or pathogen specific detection
- Notification/complaint systems from hospitals, markets, kill plants, farms, clinics, labs, other places
- Syndromic surveillance
  - Oral ulcers, highly contagious
  - Diarrhea
  - Abortions
  - Respiratory

Different kinds of outbreaks

1. *Defined population, but unknown pathogen*. May be associated with an event like a picnic or a cattle sale.
2. *Defined pathogen, but unknown population*. Must use case-control approach and best clues for exposure may be demographic distribution of cases.
3. *Defined pathogen in a known population*. You must look for the source… and subsequent exposures (traces)
4. *Unknown population and pathogen*. A cluster of syndromic cases within a large geographical area. May or may not be related.

The Epidemiologic Triad for Disease Causation

A common model used in public health illustrates the relationships among an agent, a host and the environment. It applies to biological, chemical and physical agents. For a disease or injury to occur, these basic elements must be present.



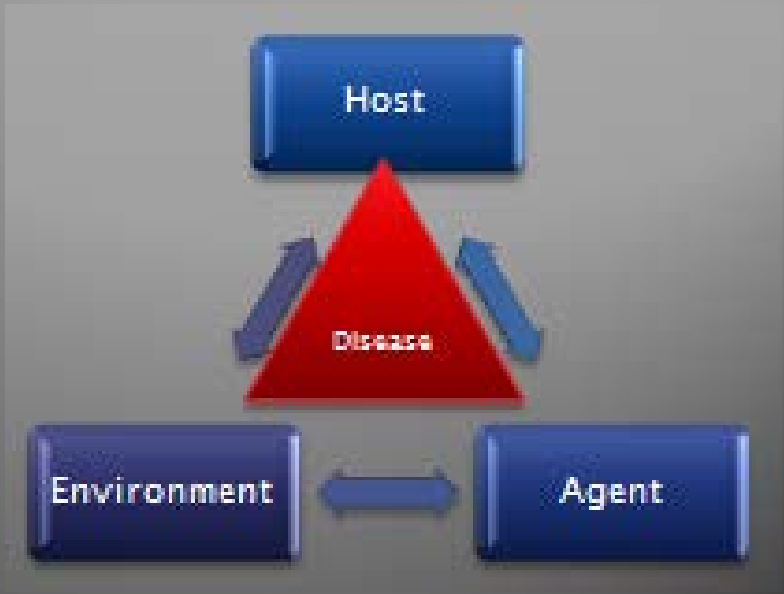
Disease occurs when an outside **agent** capable of causing the disease or injury meets a **host** that is vulnerable to the agent in an **environment** that allows the agent and host to interact.

Source: University of Minnesota Center for Public Health Preparedness in conjunction with Centers for Disease Control

The Epidemiologic Triad

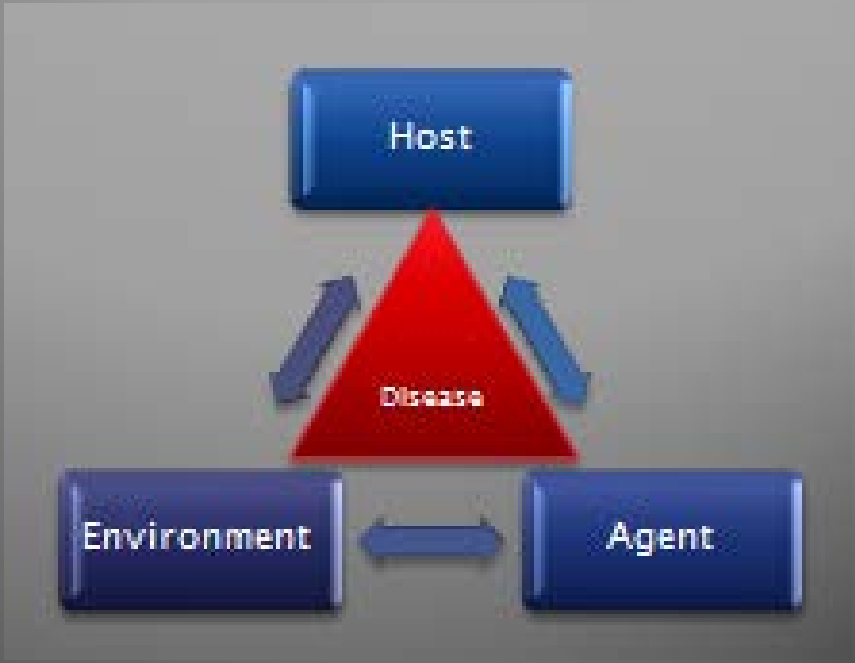
Outbreak investigations boil down to three basic questions:

- Agent
  - What is the causative agent?
- Environment
  - What is the route of transmission?
- Host
  - What is the population at risk



The Epidemiologic Triad

The hypothesis must answer these basic questions in the context of a particular outbreak. Other important aspects of the outbreak will be related to these questions.



Typical Questions to Answer in any Outbreak

- Identify disease or etiologic agent
- Identify animals/persons at risk
- Identify mode or vehicle of transmission
- Identify source of exposure
- Identify subsequent exposures
- Identify contributing factors
- Identify mitigation procedures

Review Quiz Question

- What 3 basic questions does every hypothesis need to address in order to accurately explain an outbreak?
  1. What is the causative agent?
  2. What is the population at risk?
  3. What is the route(s) of transmission?

Definition: Hypothesis

1. A supposition, arrived at from observation or reflection, that leads to refutable predictions.
2. Any conjecture cast in a form that will allow it to be tested and refuted.

Steps to Generating a Hypothesis

1. Review "descriptive epidemiology" (person, place, time, type of outbreak, clinical signs)
2. Review literature, conduct interviews and formulate your best guess as to most likely
   - *cause or agent,*
   - *route of exposure* and
   - *population at risk.*
3. Try to come up with a scenario that incorporates as much data as possible

Steps to Generating a Hypothesis

4. Pay particular attention to unusual cases as they may turn out to be the index case and provide information on initial exposure
5. Consult with experts from the lab, experienced epidemiologists and trusted colleagues to help formulate your best initial hypothesis. There is strength and wisdom in a group effort

Outbreak Investigation Illustration

- Laboratory
  - Confirm diagnosis
  - DNA fingerprints?
  - Presence in environment
- Environment
  - Fomites
  - Feed
  - Soil, water, pasture
- Epidemiology
  - Person, place, time
  - Formulate hypothesis
  - Test hypothesis

Clues to Determining Disease

1. Diagnostic tests and laboratory information
2. Necropsy
3. Clinical signs
4. Incubation period
5. Type of transmission or epidemiology curve
6. Host animal/person signalment

Clues to Determining Route of Exposure

1. Line listing of cases
2. Case-control approach
3. 2X2 Table odds ratios and relative risk ratios
4. Type of disease (if known)
5. Type of transmission or the epidemiology curve
6. Known contacts with cases
7. Sales records, purchase records, adjacent farms, visitors to farm, local market records, farm employees

Clues to Determining Population at Risk

1. Line listing of cases
2. Signalment of cases (species, age, breed, sex)
3. Type of disease (if known)
4. Type of transmission or epidemiology curve
5. Known contacts with cases or exposed
6. Interviews and records of possible contacts with cases or exposed

Summary

- Remember that your hypothesis is only as good as your epidemiologic investigation
- Your hypothesis is your best educated guess
- Hypothesis should summarize three basic questions:
  - Host (population at risk)
  - Agent (biological, chemical, physical)
  - Environment (route of exposure, interaction between agent and host)
- Know the clues for determining agent, population at risk and route of exposure
- Sharpen your hypothesis by discussing it with colleagues

References

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