PHC 6934 Population Assessment II
Module 7 – Supplement
Field Epidemiology
Field Epidemiology

• Disease occurrence

• Outbreak Investigation

• Clusters
Disease Occurrence

• Usual Prevalence
  – Baseline level of disease
  – Expected level of disease
  – Background level of disease

• Three Levels of Usual Prevalence
  – Endemic level
    • persistent level
    • low to moderate occurrence
  – Hyperendemic level
    • persistent level
    • high level of occurrence
  – Sporadic level
    • irregular pattern of occurrence
    • occasional cases occurring at regular intervals
Endemic, Epidemic, Pandemic

- **Endemic**
  - habitual presence of a disease within a given geographic area or
  - usual occurrence of a disease in a given area

**Increase in Prevalence**

- **Epidemic**
  - occurrence in community or region of a group of illnesses of similar nature,
  - *clearly in excess* of normal expectancy, and
  - derived from a common or from a propagated source

- **Pandemic**
  - worldwide epidemic
  - spread of disease across countries or continents
Epidemics

- Occurrence of a specific disease that is *clearly in excess* of normal expectations for a given population, time and place
  - Usual frequency = endemic level
- To determine an epidemic
  - compare number of cases at a specific time and place in a population
  - to the baseline or endemic level
Definitions of outbreak, pandemic and disease cluster.

- "Clearly in excess" does not have to be statistically different from expected levels

- **Disease outbreak**: epidemic confined to a localized geographic area

- **Pandemic**: epidemic that crosses international borders and affects large numbers

- **Disease cluster**: occurrence of a group of cases (usually of a rare disease) in space and time whose distribution is believed not to be due to chance
Dictionary definitions

• Outbreak
  “Epidemic limited to a localized increase in the incidence of a disease” (Last 1995)

• Cluster
  “Aggregation of relatively uncommon events or diseases in space and/or time in amounts that are believed or perceived to be greater than could be expected by chance” (Last 1995)
Why do outbreaks occur?

• Increase in amount or virulence of agent

• Recent intro of agent into new setting

• Enhanced mode of transmission, exposing more susceptible individuals

• Factors that increase host exposure or involve intro through new portals of entry
Disease outbreak investigation

• Purpose:
  – to identify the cause so that disease can be controlled or
  – to prevent further spread

• Disease outbreaks:
  – Can learn more about natural history
  – Identify important risk factors
  – Test control procedures
Steps in the Outbreak Investigation Process

*Descriptive Phase*
1. Determine an outbreak exists
2. Confirm diagnosis of reported case
3. Define case status
4. Describe data using person/place/time
5. Determine who is at risk
Steps in the Outbreak Investigation Process (cont.)

Analytic Phase
6. Develop a hypothesis

7. Compare hypothesis with established facts

8. Conduct systematic study

9. Report findings

10. Execute control & preventive measures
Steps – Descriptive phase

- Verify if it is really an outbreak.
  - Using surveillance or reportable diseases

- Confirm the diagnosis:
  - standard laboratory procedures;
  - sometimes unable to confirm every case or perhaps clinical dx is the norm
Steps – Descriptive phase

• Prepare a case definition and count cases
  – Case Definition
    • Set of standard criteria to decide if a person has a particular disease or other health-related condition.
    • Consists of clinical criteria, and, sometimes, limitations on person, time, and place.

  – Criteria for caseness
    • Simple and objective (possible, probable, confirmed)
    • Collect demographic info, time of onset, clinical features, possible exposures, contacts (questionnaire)
Case definition for Public Health Surveillance
CDC. Example: Anthrax.

Anthrax:

**Clinical description:**
Illness with acute onset characterized by several distinct clinical forms:
- **Cutaneous** (a skin lesion evolving over 2 to 6 days from a papule, through a vesicular stage, to a depressed black eschar).
- **Inhalation** (a brief prodrome resembling a viral respiratory illness followed by development of hypoxia and dyspnea, with x-ray evidence of mediastinal widening).
- **Intestinal** (severe abdominal distress followed by fever and signs of septicemia)
- **Oropharyngeal** (mucosal lesion in the oral cavity or oropharynx, cervical adenopathy and edema, and fever).
Case definition for Public Health Surveillance

CDC. Example: Anthrax (cont).

**Laboratory Criteria for Diagnosis**

- Isolation of *Bacillus anthracis* from a clinical specimen, or
- Fourfold or greater rise in either the anthrax enzyme-linked immunoabsorbent assay (ELISA) or electrophoretics immunotransblot (EITB) titer between acute- and convalescent-phase serum specimens obtained greater than or equal to 2 weeks apart, or
- Anthrax ELISA titer greater than or equal to 64 or an EITB reaction to the protective antigen and/or lethal factor bands in one or more serum samples obtained after onset of symptoms, or
- Demonstration of *B. anthracis* in a clinical specimen by immunoflorescence

**Case Classification**

- **Confirmed**: a clinically compatible illness that is lab confirmed
Steps – Descriptive phase (cont).

- Characterize cases by person, place and time (descriptive data) to suggest hypotheses
  - Update as investigation proceeds
  - Person: Demographic variables + exposure (foods eaten, lifestyle, behaviors, etc)
  - Place (water supplies, wooded areas)
  - Time (time of onset)
Steps – Descriptive phase (cont).

Describe the cases according to the variables: person, place and time

- **Person**
  - 1. What were age and sex specific attack rates?
  - 2. What age and sex groups have highest, lowest risk of illness
  - 3. How do case characteristics differ from those of the general population

- **Place**
  - 1. What is the most significant geographic distribution of cases?
  - 2. What are attack rates by place?

- **Time**
  - 1. What is the exact period of the outbreak?
  - 2. Given the diagnosis, what is the probable period of exposure?
  - What pattern does the outbreak follow across time? (common, point, propagated)
Steps – Descriptive phase (cont).

• Identify who is at risk.

• Index case:
  – First case defined that comes to attention
  – Can be person who introduced agent (food handler, employee with Hepatitis A).
Epidemic curve

- Plot of distribution of cases by time of disease onset
  - Construct for epidemic in its entirety
  - For subgroups by person/place

Fig. 5-7. A. Cases of mild typhus in Montgomery, Alabama, 1922–1925, plotted according to residence. B. Cases of mild typhus in Montgomery, Alabama, 1922–1925, plotted according to place of employment (or residence, if unemployed). (From K. F. Maxcy, An epidemiological study of endemic typhus [Brill’s disease] in the Southeastern United States with special reference to its mode of transmission. Public Health Rep. 41:2967, 1926.)
Steps – Analytic phase

• Formulate and test hypotheses
  – Case-control studies
  – Retrospective cohort studies

• Prepare report and implement control/prevention measures
Attack rates

• Cumulative incidence rates
  – applies to a narrowly but well-defined population
  – observed over a limited time period
• Usually reported x 100 (percents)
• Attack rates by person variables:
  – age,
  – gender,
  – race,
  – occupation,
  – food eaten, etc
Attack rates (AR)

- AR = Number of new cases occurring among a specified pop during a given time period
  Pop at risk at beginning of time period

\[
AR = \frac{\text{Number of new cases}}{\text{Pop at risk at beginning of time period}} \times 100
\]
Attack Rates

• Incidence Rate
  – specific to a group of people
  – narrow time period

• Investigation of a foodborne outbreak
  – Quick and dirty method
    • calculate the attack rates for those exposed to a food item
    • calculate the attack rates for those not exposed to a food item
    • compare the attack rates
Secondary Attack Rates

• Attack rates that are calculated using incidence rates among Contacts of cases
  – second wave

• Exercise you will complete as post-class

• http://www.cdc.gov/epicasestudies
Types of Outbreaks

• Common Source Epidemics
  – Point Source Epidemics (brief and simultaneous)
  – Continuing (beyond brief and not simultaneous)
  – Intermittent (irregular)

• Propagated Epidemics (direct or indirect)

• Mixed Epidemics (combination of common & prop.)
Classification of Epidemics

• Common Source Epidemic
  
  – all susceptible individuals have a common exposure
  – indirect transmission most likely (vehicle)
  – shape of epidemic curve

  • fewest number of cases before the minimum incubation period
  • midline of the curve defines the usual incubation period
  • unimodal shape typical
  • prolonged exposure to source of outbreak widens the apex of the common source curve
Classification of Epidemics (cont.)

- **Common Source Epidemic** (cont.)
  - **Point Source Epidemics**
    - type of common source epidemic in which all susceptible individuals are exposed at one point in time
      - usually brief period
    - Shape of curve
      - typically sharp peak only one incubation period
      - decline in curve is more rapid
  - **Continuing source**
    - Common source where the exposure is prolonged beyond a brief period, and exposure is not simultaneous (park contaminated water consumed along days).
    - Curve shows a rapid rise in number of cases to a plateau then gradual decline.
  - **Intermittent.**
Classification of Epidemics (cont.)

- **Propagative** (Progressive transmitted person to person or by a vector)
  - **Mode of transmission**
    - **direct**
      - genital, anal, oral, and skin contact
      - directly aerosolized respiratory droplets
        » fungi, bacterial spores, parasites
    - **indirect**
      - vectorborne
        » arthropods
      - airborne
        » dried droplet residues and dust, serial transmission

- **Mixed Epidemics** (combination of common & prop.)
Disease clusters

• True disease clusters have a common cause that is unique for place and/or time.
• Often presumed to be environmental (toxic substance)
  – Love Canal- NY, chemicals and low birth weight and birth defects
  – Chernobyl- nuclear reactor released radiation: death, later cancer
  – Electric-power lines- childhood cancers
  – Woburn, MA- chemical contaminated wells and leukemia
  – Pacific Gas & Electric Company's Hinkley, California gas compressor station (Erin Brockovich story)
Suspected disease cluster

- Due to chance
- Represents a collection of different diagnoses due to a variety of unrelated causes
- Circle the population that seems to apply to the numerator
- Some occupationally-related disease clusters are true
- Rarely have community-based clusters been inferred to be real (but make good topics for movies)
Problems in investigating disease clusters

• Usually disease is rather rare, making traditional statistical methods difficult to apply and adequate power is difficult to achieve

• Case definitions are often imprecise – may represent several diseases, each with its own cause(s).

• Often impossible to identify an appropriate population at risk from which to develop incidence rates

• Long latency periods between exposures and outcomes

• However, much controversy, particularly among the public