College of Nursing

University of Central Florida

Introduction to Epidemiology:

- Epidemiology defined
- Historical perspectives of epidemiology practice
- Core epidemiological functions and approach
- Descriptive and analytic epidemiology
- Concepts of disease occurrence; chain of infection
- Epidemic management of disease occurrence

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NGR 7642: Epidemiology Principles in Advanced Practice Nursing

Definition of Epidemiology

- Study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems
- Epidemiology is data driven
- It is essential that the collection of this data remain systematic and unbiased
- Draws from the fields of biostatistics, economic, social, and behavioral sciences
- Applies the scientific method and use of probability, statistics, hypothesis testing, and causal reasoning
- Drives the evaluation of public health initiatives and is a major factor in the formulation and funding of health and social policies
- 5 W's of epidemiology:
  - What: Dx or health event
  - Who: Person
  - Where: Place
  - When: Time
  - Why: Causes, risk factors, and modes of transmission

Definition of Epidemiology

- Distribution of health events in a population defined by:
  - Frequency: # of health events: population size
  - Pattern: Occurrence of health-related events by time, place, and person (descriptive epidemiology)
- Determinants:
  - Epidemiology attempts to define the causes and other factors that influence the occurrence of diseases and other health-related events
  - Illnesses do not occur randomly; occur when the right accumulation of risk factors or determinants exists within an individual
  - Epidemiologists must determine where groups with higher prevalence rates differ in demographics, genetic/immunologic makeup, behaviors, environmental exposures, or other risk factors
- Health-related states:
  - Epidemiologists study more than just communicable diseases; they study **anything** that affects the well-being of a population, known as health-related states.

Definition of Epidemiology

- Epidemiology is distinct from clinical care "the patient" is the collective health of a defined community
- Epidemiology in Mathematical Formula:

  (descriptive + analytic) epidemiology + experience + epidemiologic judgment + understanding of local conditions =

<u>diagnosis and application of appropriate interventions</u>

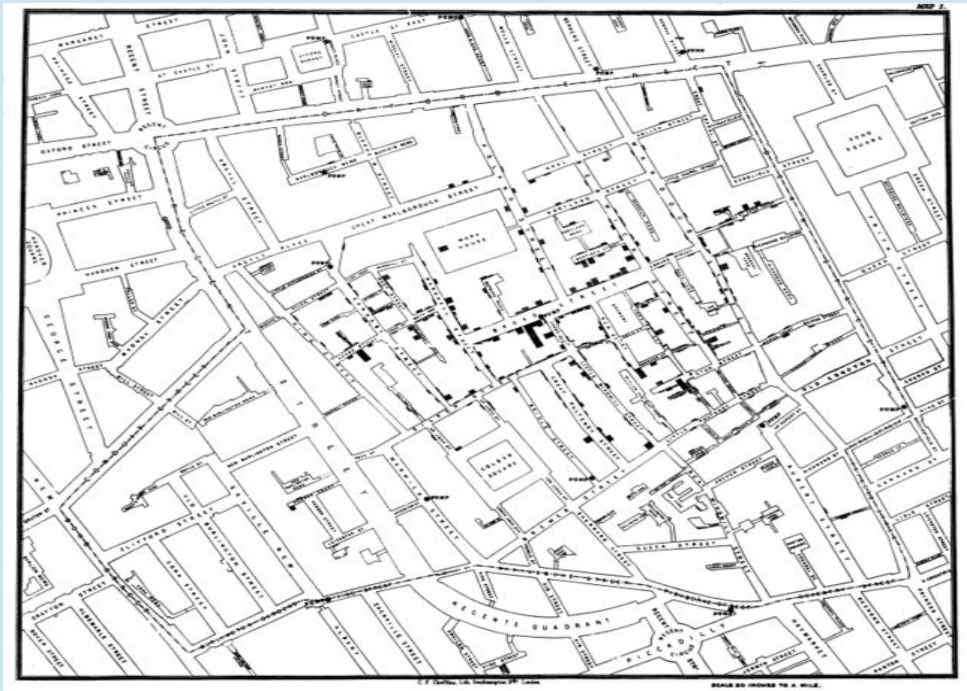
Historical Evolution of Epidemiology

- Nearly 2,500 years old
- Hippocrates actually attempted to erase supernatural causes of illness and replace it with natural causality (environment, host factors, behaviors) around 400 BC
- John Gaunt began to publish data related to morbidity/mortality in 1662
- William Farr further Gaunt's work by augmenting statistics related to mortality in Britain (1800); he is considered the father of modern vital statistics and surveillance
- John Snow (1854) applied the scientific method to the critical inquiry of public health and disease surveillance:

descriptive epidemiology→ hypothesis generation→ hypothesis testing→ application

Historical Evolution of Epidemiology

- John Snow:
  - Constructed the first spot map of deaths from cholera in Golden Square London



Historical Evolution of Epidemiology

Historical Evolution of Epidemiology

  - Snow revisited the cholera data of 1854 and established the method used today for assessing an outbreak: Time, Place, Person examination of populations at risk
  - Snow was an effective policy change agent and was able to demonstrate the power of rigorous scientific application to the study of disease outbreaks, all with no knowledge of the existence of microorganisms!
- 19th and 20th Centuries:
  - Focused on acute infectious disease until the 1930s and 1940s
  - After World War II, epidemiology flourished with several groundbreaking inquires in chronic and noninfectious disease:
    - Doll and Hill linked smoking to lung cancer
    - Framingham study linking heart disease with risk factors associated with atherosclerosis
    - Eradication of naturally-occurring smallpox in the 1960s and 1970s
    - 1980s saw the proliferation of studies of injuries and violence
    - 1990s saw expansion of molecular and genetic epidemiology, looking at molecules and genes associated with increased risk of disease
    - New infectious diseases emerged in the 1980/90s: ebola, HIV/AIDS, SARS, resistant-TB, SARS, Avian flu)
    - 9/11/01 spurred expansion of study into bioterrorism and spread of organisms through biologic welfare

Applications of Epidemiology

- Assessing the Community's Health:
  - Assists in the development, implementation and evaluation of policy through a factual framework
  - To assess a community's health, data related to person, place, and time are analyzed
  - Questions must be asked:
    - What are the actual and potential health problems in the community?
    - Where are they occurring?
    - Which problems have declined over time?
    - Which ones are increasing or have the potential to increase?
    - How do these patterns relate to the level and distribution of public health services available?
- Making Individual Decisions:
  - Epidemiologic data drive our daily decisions:
    - Do I need to quite smoking?
    - Should I climb the stairs or take the elevator?
    - Salad or a cheeseburger and French fries?
    - Should I use a condom?

Applications of Epidemiology

- Completing the Clinical Picture:
  - Health providers collect clinical data and report findings to public health agencies, which assist in defining causality and commonality in clients:
    - linking of smoking with lip, mouth, throat, and lung CA
    - eosinophila-associated myalgia syndrome and SARS
- Searching for Causes:
  - Although epidemiology cannot *prove* causality, it can provide strong evidence for links and intervention:
    - John Snow study
    - 1999 withdrawal of rotavirus vaccine due to links with intussception
    - Outbreak of pneumonia among persons attending the 1976 American Legion Convention in Philadelphia (* Legionnaire's bacillus not isolated from post-mortem lung tissue until 6 months later)

Core Epidemiologic Functions

- 5 major tasks of epidemiology in public health:
  - Public health surveillance
  - Field investigation
  - Analytic studies
  - Evaluation
  - Linkages
  - Policy development (recently added)
  - Public health surveillance (instrument design, data mgmt, descriptive methods/ graphing, data interpretation, and scientific writing/ presentation):
    - Ongoing, systematic collection, analysis, interpretation, and dissemination of health data to help public health decision making and action
    - Monitoring the pulse of the community; "information for action"
    - Use morbidity and mortality reports, comprised by local and state health departments: include data on all reportable diseases
    - Other data used include those from individual and disease cluster investigations and public health program data (immunizations, registries, etc.)
    - Health officials review what little data they have in cases and assess for trends, patterns, and variations in presentations

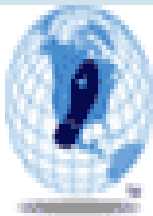
Core Epidemiologic Functions

– Field Investigation:

- Could be as simple as phone calls– but could be extensive with a staff of MDs, RNs, NPs, administrators, etc.
- STD investigations: Important to ID an infected person's partners to help determine latent disease presence
- Also used to ID fomites and other vehicles of transmission: *E. coli* in ground beef or juices
- Can aid in ID of natural Hx, clinical spectrum, descriptive epidemiology, and risk factors of a disease

Epidemic Intelligence Service

Office of Workforce and Career Development



Core Epidemiologic Functions

- Analytic Studies:
  - Used to evaluate the credibility of hypotheses about causes and modes of transmission
  - Must have a valid comparison group and involves:

    - Design: determining the appropriate research strategy and study design, writing justifications and protocols, calculating sample sizes, deciding on selection criteria, choosing comparison groups, and designing questionnaires
    - Conduct: Actual data collection (obtaining approvals and clearances, adhering to ethical principles, tracking down and interviewing, collecting/handling specimens, and data mgmt)

    - Analysis: describing sample characteristics, rate calculation, creation of comparative tables, measures of association, significance testing, confidence intervals, etc.
    - Interpretation: Putting study findings into perspective and making sound recommendations

Core Epidemiologic Functions

- Evaluation:
  - The process of determining, as systematically and objectively as possible, the relevance, effectiveness, efficiency, and impact of activities with respect to established goals
    - Effectiveness: ability of a program to produce intended results in the field
    - Efficacy: ability to produce results under ideal circumstances
    - Efficiency: ability of a program to produce intended results with minimum expenditure of time and resources
  - Can be Formative (focus on plans); Operations (process evaluation); or impact (summative) evaluation

Core Epidemiologic Functions

- Linkages:
  - Important to maintain strong ties with area, state, and federal agencies as most incidences cross boundaries
  - Mechanisms for sustaining these include official memoranda of understanding, sharing of public health data, and informal networking
- Policy Development:
  - Epidemiologists provide input, testimony, and recommendations regarding disease control strategies, reportable disease regulations, and healthcare policy

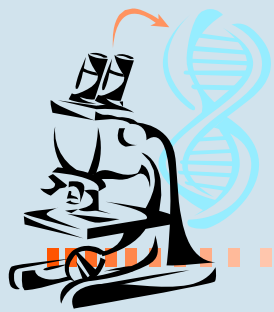
COHPA Symbol & Epidemiology

The Epidemiologic Approach

- Counts cases or health events, and describes them in terms of time, place, and person
- Divides the number of cases by an appropriate denominator to calculate rates
- Compares these rates over time or for different groups of people
- Define a case → finds and collects data about case-patients → characterizes by time, place, and person → calculate disease rate by dividing # of cases by total population size → compare this rate with comparison group
- Defining a Case:
  - Defined using case definition: standard criteria for classifying whether a person has a particular disease, syndrome, or other health condition
  - Definitions should be standardized so comparisons are valid
  - CDC and CSTE adopted standard notifiable infectious diseases (see notes/outline), CDC + CSTE + ASTCDPD adopted standard definitions for 73 chronic diseases
- Components of a Case Definition for Outbreak Investigations:
  - Consists of clinical criteria (confirmatory lab analyses, combinations of S/S and other findings) and limitations on time, place, and person
  - Compare *Listeria monocytogenes* in national surveillance case definition vs outbreak

The Epidemiologic Approach

- *Listeria monocytogenes* Surveillance Definition:
  - **Clinical description:**
    - In adults, invasive disease caused by *Listeria monocytogenes* manifests most commonly as meningitis or bacteremia; infection during pregnancy may result in fetal loss through miscarriage or stillbirth, or neonatal meningitis or bacteremia. Other manifestations can also be observed.
  - **Laboratory criteria for diagnosis:**
    - Isolation of *L. monocytogenes* from a normally sterile site (e.g., blood or cerebrospinal fluid [CSF] or, less commonly, joint, pleural, or pericardial fluid)
    - In the setting of miscarriage or stillbirth, isolation of *L. monocytogenes* from placental or fetal tissue
  - **Case classification:**
    - *Confirmed*: A clinically compatible case that is laboratory-confirmed
  - **Comment:**
    - The usefulness of other laboratory methods such fluorescent antibody testing or polymerase chain reaction to diagnose invasive listeriosis has not been established.
- *Listeria monocytogenes* Outbreak Definition:
  - Clinical compatible illness w/ *L. monocytogenes* isolated:
    - From a normally sterile site
    - In a resident of Winston-Salem, NC
    - With onset between 10/24/00-1/4/01



The Epidemiologic Approach

- Oftentimes, case definitions don't have solid objective (eg: lab) clinical findings, for example:

- Kawasaki Syndrome:
  - **Clinical case definition**
    - A febrile illness of greater than or equal to 5 days' duration, with at least four of the five following physical findings and no other more reasonable explanation for the observed clinical findings:
    - Bilateral conjunctival injection
    - Oral changes (erythema of lips or oropharynx, strawberry tongue, or fissuring of the lips)
    - Peripheral extremity changes (edema, erythema, or generalized or periungual desquamation)
    - Rash
    - Cervical lymphadenopathy (at least one lymph node greater than or equal to 1.5 cm in diameter)
  - **Laboratory criteria for diagnosis**
    - None
  - **Case classification**
    - *Confirmed*: a case that meets the clinical case definition
  - **Comment**
    - If fever disappears after intravenous gamma globulin therapy is started, fever may be of less than 5 days' duration, and the clinical case definition may still be met.

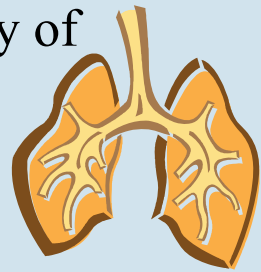
The Epidemiologic Approach

- Often, cases have different criteria according to differing criteria, for example:

- Measles (Rubeola):
  - **Clinical case definition**
    - An illness characterized by all the following; a generalized rash lasting greater than or equal to 3 days; a temperature greater than or equal to 101.0°F (greater than or equal to 38.3°C); cough, coryza, or conjunctivitis
  - **Laboratory criteria for diagnosis**
    - Positive serologic test for measles immunoglobulin M antibody, or Significant rise in measles antibody level by any standard serologic assay, or Isolation of measles virus from a clinical specimen
  - **Case classification**
    - *Suspected*: any febrile illness 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.
  - **Comment**
    - Confirmed cases should be reported to NNDSS. An *imported* case has its source outside the country or state. Rash onset occurs within 18 days after entering the jurisdiction, and illness cannot be linked to local transmission. Imported cases should be classified as:
    - *International*. A case that is imported from another country
    - *Out-of-State*. A case that is imported from another state in the United States. The possibility that a patient was exposed within his or her state of residence should be excluded; therefore, the patient either must have been out of state continuously for the entire period of possible exposure (at least 7-18 days before onset of rash) or have had one of the following types of exposure while out of state: a) face-to-face contact with a person who had either a probable or confirmed case or b) attendance in the same institution as a person who had a case of measles (e.g., in a school, classroom, or day care center).
    - An *indigenous* case is defined as a case of measles that is not imported. Cases that are linked to imported cases should be classified as indigenous if the exposure to the imported case occurred in the reporting state. Any case that cannot be proved to be imported should be classified as indigenous.

The Epidemiologic Approach

- Modifying Case Definitions:
  - Case definitions can evolve over time with the continual discovery of information about a disease; an example is SARS:
    - Classified in *MMWR* on 3/21/03
    - 2 weeks later, lab confirmation was added with the discovery of the coronavirus as etiology
    - By December of 2003, the definition became very complex (see notes/outline)



- Variation in Case Definitions:
  - Sensitive case definitions are "loose" in hoping of capturing most or all of the true cases
    - Rubella is one example: it's definition is "any generalized rash or illness of acute onset"
      - Of course, this would include a wide array of potential etiologies
      - + = potential for large ID of cases; - = includes other illnesses as well
  - Strict case definitions significantly narrow the scope of capturing potential etiologies/disease
    - *Salmonella* Agona is a good example: Cases must include only those with confirmed laboratory infection with this organism
      - Negative aspect includes need to test everyone with symptoms to confirm cases

The Epidemiologic Approach

- Using Counts and Rates:
  - Counts allow health officials to track patterns of disease by time, place, and person; helps to assess for clusters.
  - Counts often placed in context of their population:
    - 42,275 new cases of AIDS (2002)
    - This value is then divided by the total US (2002) population to derive a prevalence rate of 15.3 cases per 100,000. HIV per 100,000 in IN:

(Number of living cumulative cases of HIV diagnosed through 2000/2000 population)*100,000

(3103/6,080,485)*100,000 = prevalence of 51.0 per 100,000 population

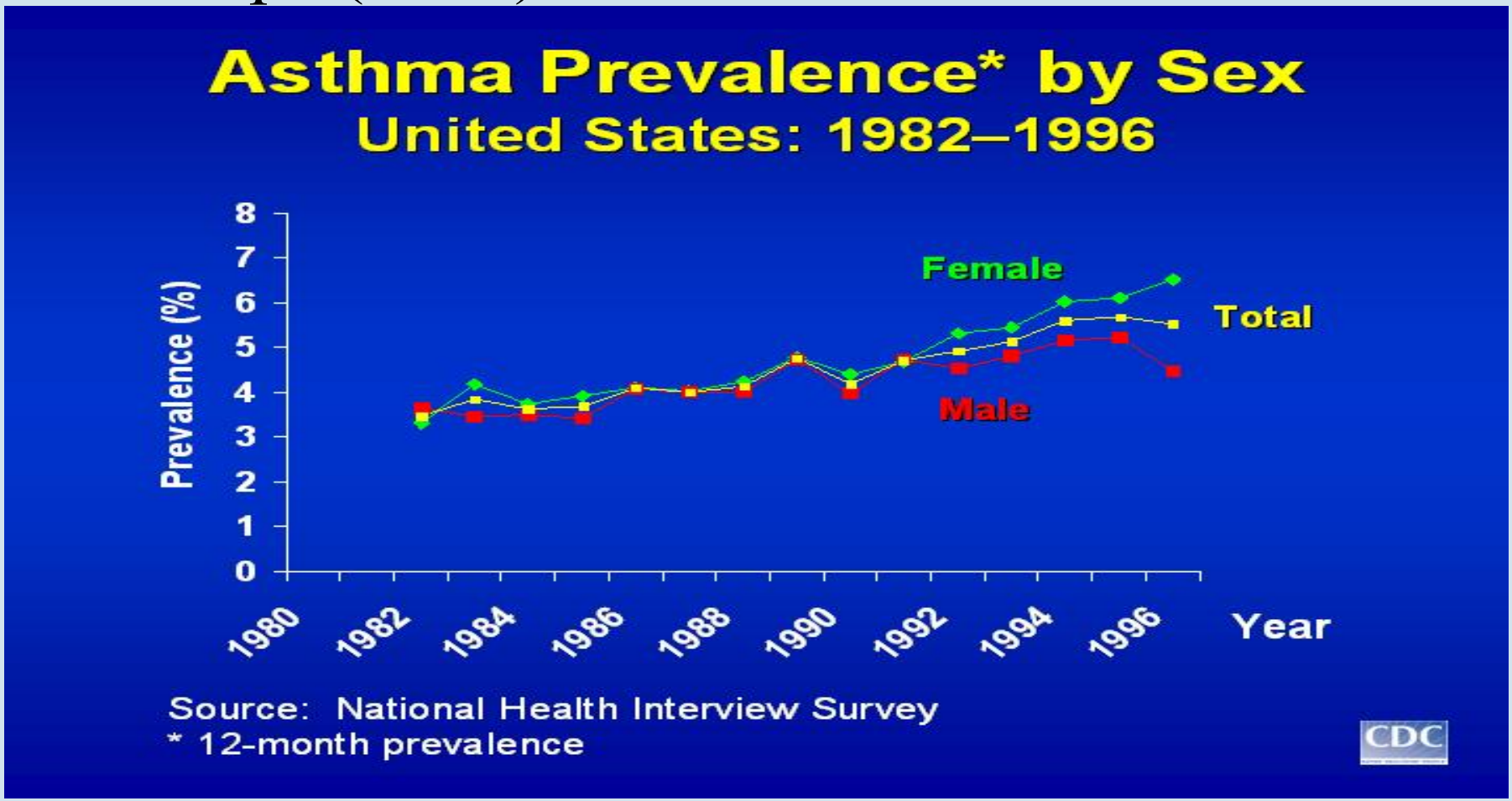
    - This is essential when looking at geographic variations in prevalence (eg: Compare HIV infection rates in Orlando with those of San Francisco, NYC, or Lincoln, NE).
    - Also effective measure of changes in prevalence rates in time (comparing rates of polio in 2007 with the rates in 1947).

The Epidemiologic Approach

- Descriptive Epidemiology (DE):
  - 5 W's of DE: What (issue/concern); Who (person); Where (place); When (time); Why/How (cause, risk factors, transmission modes)
  - Analyzing data by time, place, and person, allows the epidemiologist to scrutinize data (ID its limitations, its commonalities)
  - Epidemiologist assesses patterns of problems (which months, neighborhoods, most/least cases per group/s)
  - Allows easier tabulation of data for graphing, tabling, and mapping
  - Formulate hypotheses based on the data of time, place, and person (Why were homosexual men developing immunodeficiency in San Francisco in the early 1980's?)
  - Time:
    - Diseases can vary by time of year (influenza—winter; West Nile virus– Aug-Sept)
    - Examining time allows health officials to target interventions during times of high risk and more closely assess mode of transmission
    - Time data depictions are usually in line/bar graphical forms with the X-axis showing rates and the Y-axis showing times

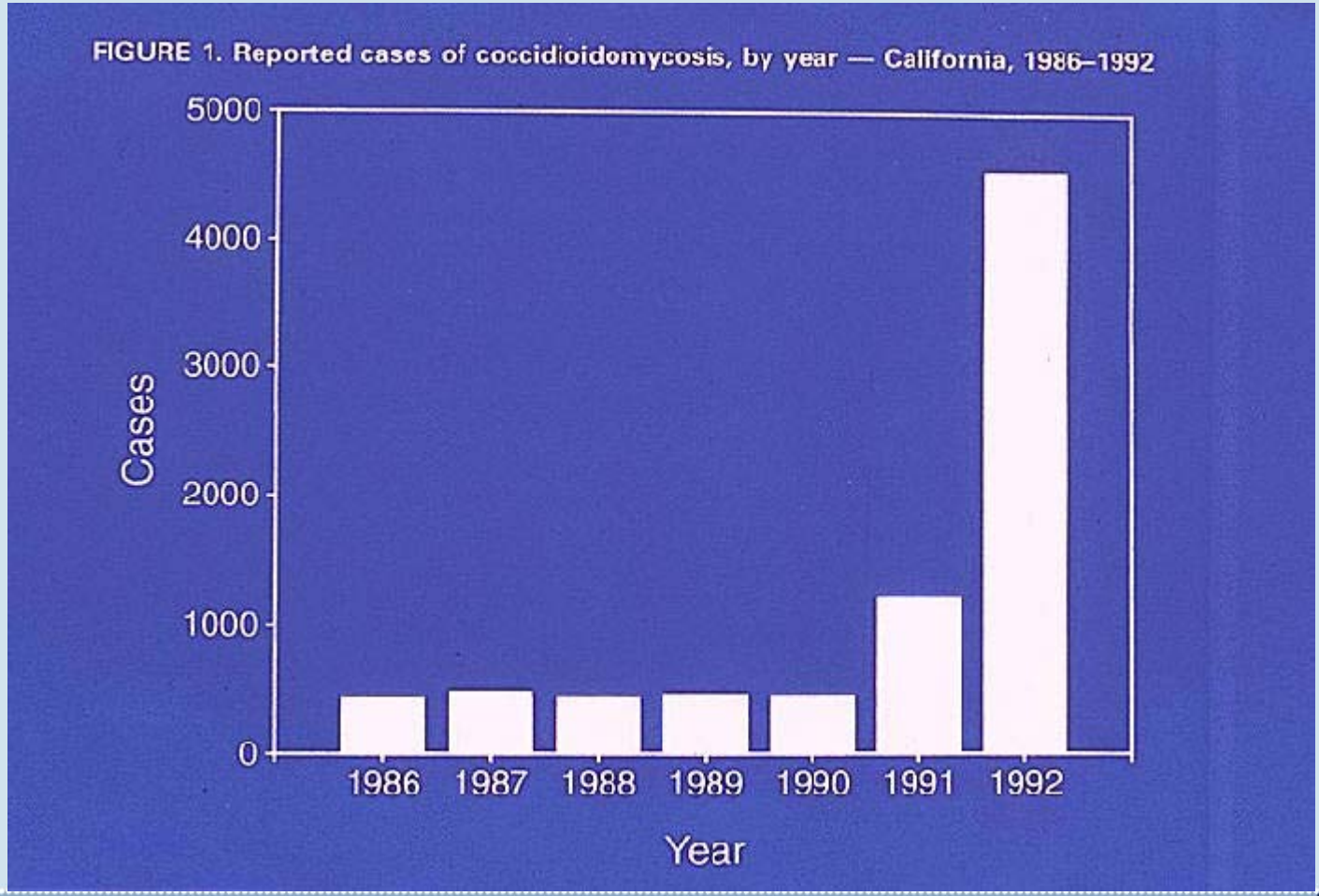
The Epidemiologic Approach

Line Graph (Time):



The Epidemiologic Approach

Bar Graph

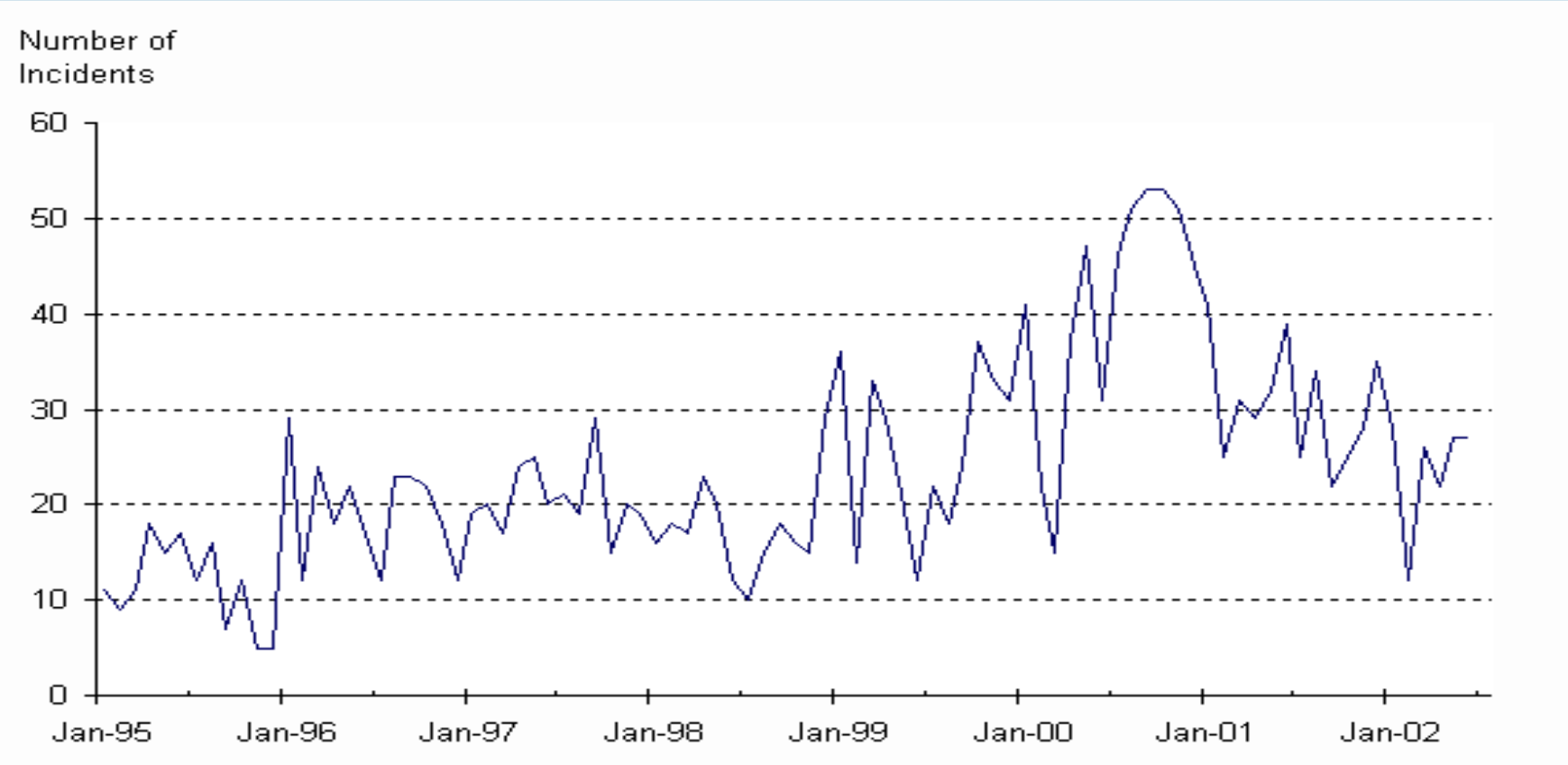


The Epidemiologic Approach

- Time:
  - Secular (long-term) graphing is done to assess changes in prevalence rates over a longer period of time (years)
  - This allows the epidemiologist to assess why rates are increasing or decreasing based on certain interventions (did rates of (obesity in a county decrease 20-years after the implementation of a nutrition and exercise training program in elementary schools—is this the only independent variable*?)
  - Seasonal graphing is useful at comparing differences in outbreaks according to time of year (compare Rubella/Influenza/Rotavirus prevalence during different times of the year)
  - Day or week and time of day graphing more effective in assessing occupational or environmental exposures which tend to occur at regular scheduled intervals (what were the survival rates of rescuers and non-rescuers in the hours after the 9/11 attacks on the WTCs?)

The Epidemiologic Approach

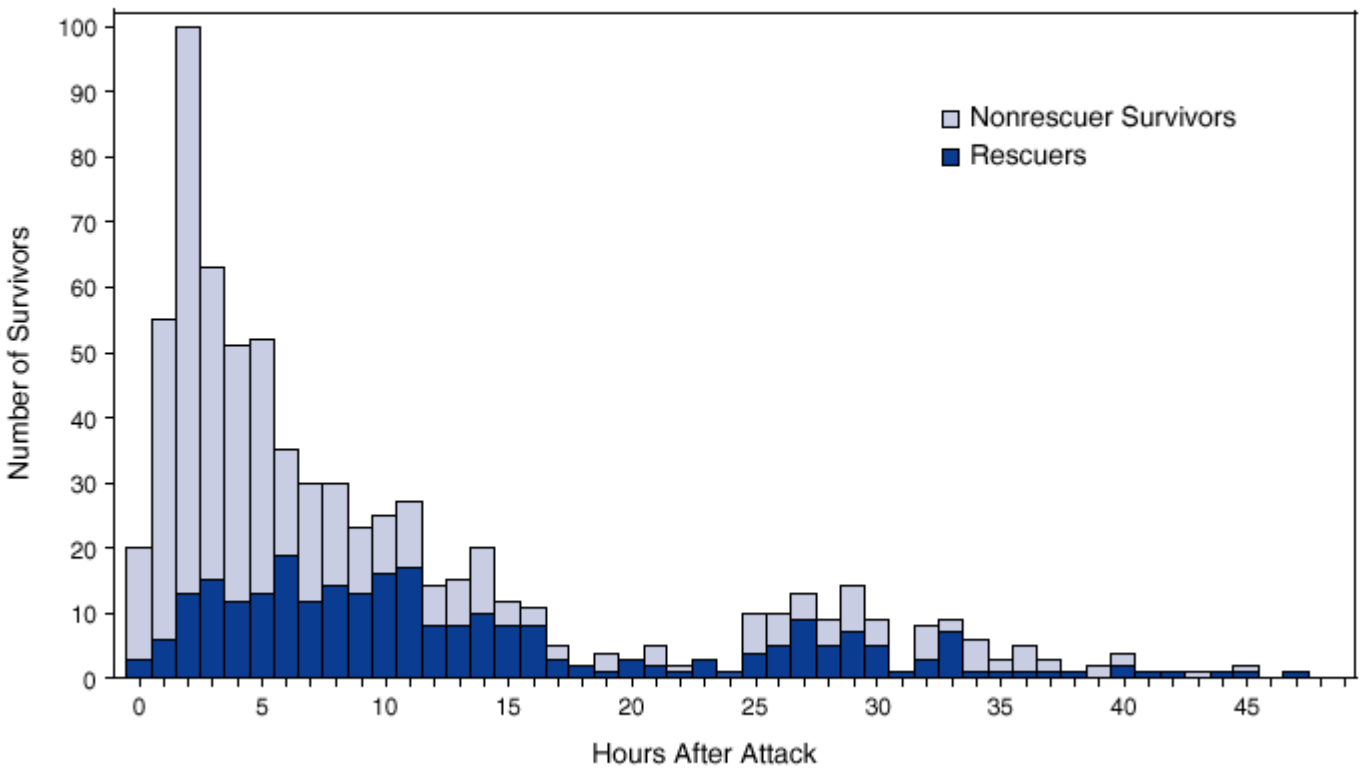
Time (Month) Graph



The Epidemiologic Approach

Time (hours) Graph

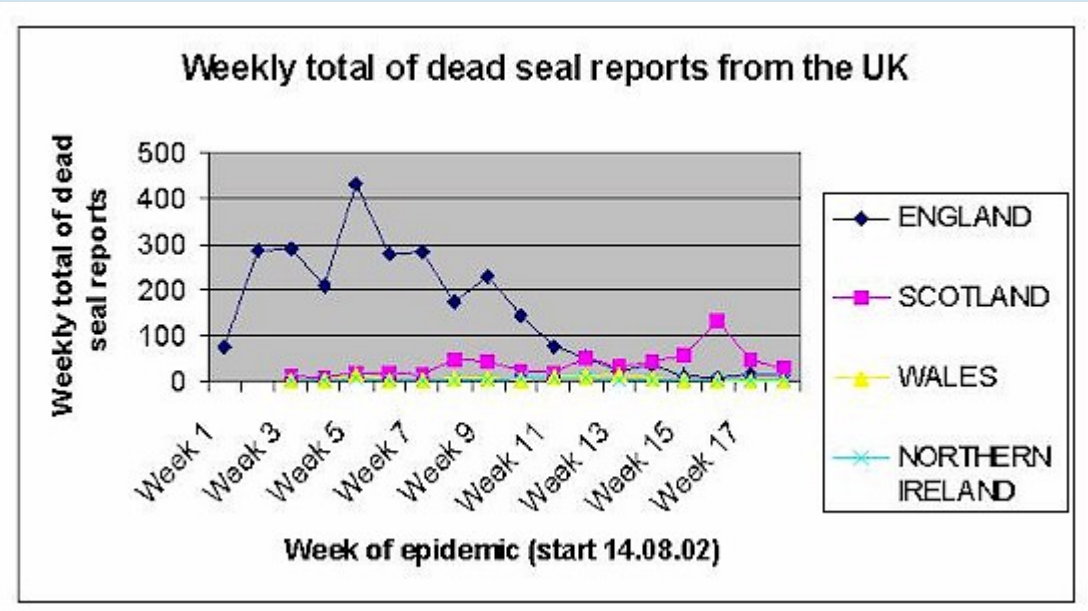
FIGURE 2. Number of World Trade Center attack survivors with injuries reported by five hospitals*, by number of hours from initial attack to medical assessment — New York City, from 8 a.m. September 11 to 8 a.m. September 13, 2001



*N=723. Time of assessment data missing for 67 (8%) of the survivors with injuries.

The Epidemiologic Approach

- Time:
  - Epidemic period graphs good at showing outbreaks by time of exposure through incubation period and initial onset of symptoms:
- EPIDEMIC PERIOD GRAPH:



The Epidemiologic Approach

– Place:
  - Examines *any* location relevant to disease occurrence (hospital unit, clinic, restaurant, city, etc.)
  - Good for ID communities at risk for investigation as to *why* these communities are at risk
  - Usually represented by tables/maps:
  - PLACE MAP (SARS--Abbreviated):

State	Total Cases	Total Suspect	Total Probable	Total Confirmed
Alabama	0	0	0	0
Alaska	1	1	0	0
Michigan	0	0	0	0
Wyoming	0	0	0	0
Total	**161**	**134**	**19**	**8**

The Epidemiologic Approach
Areas Visited: SARS

Country	**Count**	Percent
Germany	2	.9
Canada	8	3.6
China +		
Singapore	23	11
Hong Kong Special Administrative Region of China	123	56
Taiwan, China	3	1.4
Thailand	1	.5
Viet Nam	57	27
Slovenia	1	.5
United Kingdom	1	.5
Total	**219**	100

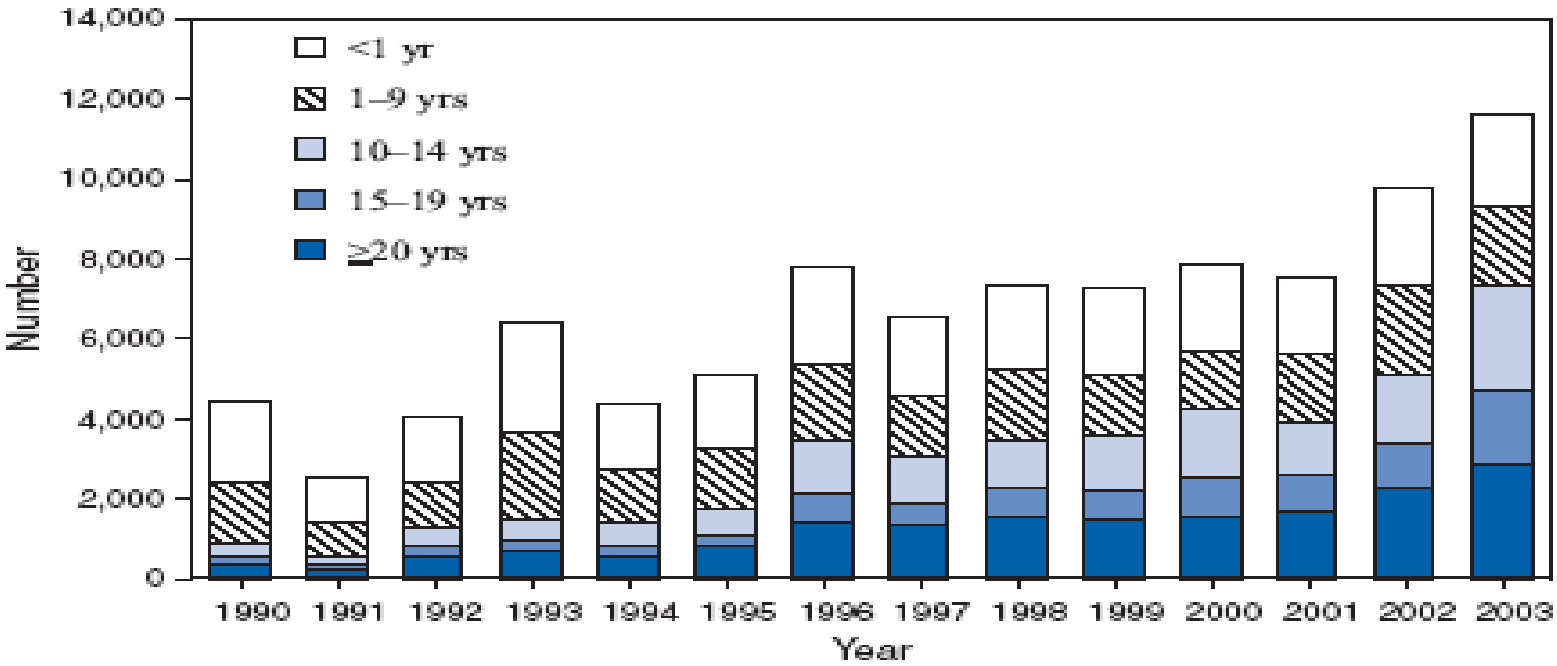
The Epidemiologic Approach

- Person:
  - Assesses disease by:
    - People (age, sex—most common assessed variables, race)
    - Biologic characteristics (immune status)
    - Acquired characteristics (marital status)
    - Activities (occupation, Rx/ETOH/etc. use, sexual behaviors)
    - Living conditions (socioeconomic status/ medical care access)
  - Age:
    - Probably **most** important "person" attribute due to the high correlation between age and illness (susceptibility, opportunity for exposure, incubation period. Physiologic response)
    - Graph intervals must be narrow or broad enough to "catch" rates (this can be assessed through descriptive statistics: mean, median, mode)

The Epidemiologic Approach

- Person Based Graph

FIGURE 1. Number of reported pertussis cases,* by year and age group — National Notifiable Diseases Surveillance System, United States, 1990–2003



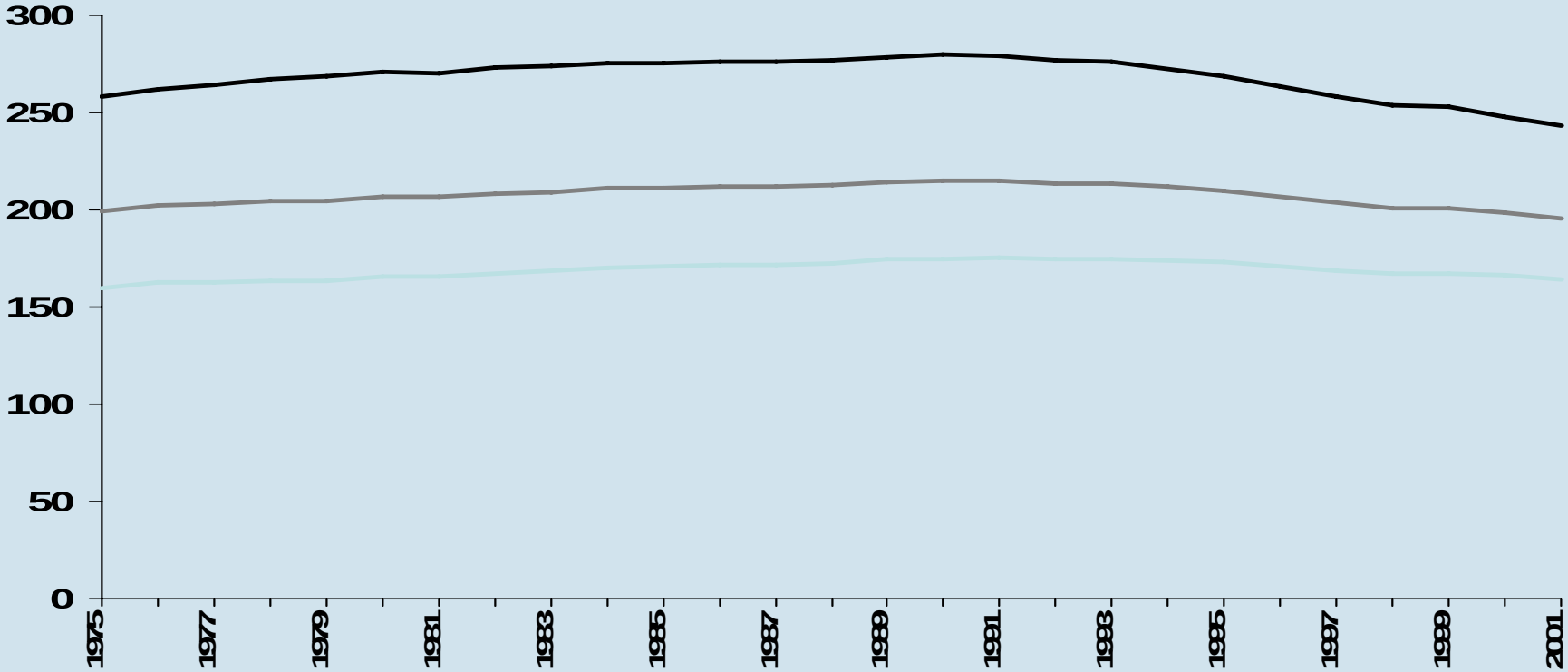
* Confirmed and probable.

The Epidemiologic Approach

- Person:
  - Sex:
    - ♂ have higher rates of illness/death for man diseases compared to females
    - EG: Physiologic exposures and risks vary between ♂/♀; pre-menopausal ♀ have lower rates of CAD due to estrogen; rates of smoking between ♂/♀ are now equal—found through graphing person and time

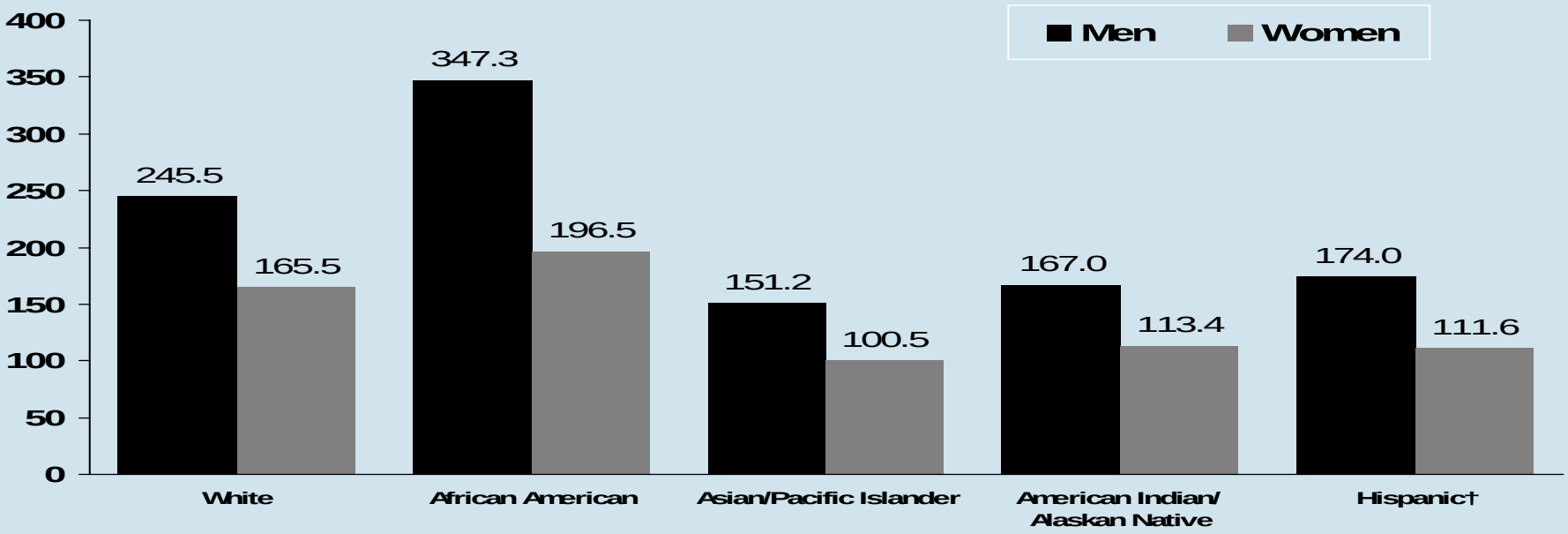
The Epidemiologic Approach

- SEX/TIME COMPARISON GRAPH (LUNG CA RATES)



The Epidemiologic Approach

- Person:
  - Ethnicity/Race: Differences can reflect susceptibility or exposure, differences in other risk factors (socioeconomic status and access to healthcare services)
  - Ethnicity Graph (Cancer Death Rates):



The Epidemiologic Approach

- Socioeconomic Status (SES):
  - Often measured through occupation, family income, and educational achievement and can indicate relationships between SES and harmful exposures, lower resistance, and less access to services
  - Diseases can occur more frequently based on SES:
    - TB more common in lower SES classes
    - Infant mortality rates higher in lower SES classes
    - Missed time from work due to illness higher in lower SES classes
    - Gout more common in higher SES classes
    - Breast CA more common in higher SES classes
    - Kawasaki Syndrome/Chronic Fatigue/ Tennis Elbow more common in higher SES classes

The Epidemiologic Approach

- Analytic Epidemiology:
  - While DE can help formulate hypotheses about disease, it cannot actually test them
  - Analytic Epidemiology helps us do this:
    - Hep A outbreak in 2003 in PA:
      - DE found almost all cases had eaten at same restaurant
      - Food preparers and servers eliminated; Need to ID food source
      - Problem: Infected individuals only able to recall popular foods
      - Solution: Develop a control group (those who ate at same restaurant but whom did not contract Hep A); show both groups picture of menu and have them ID what they did and didn't eat—Non- infected didn't eat salsa at same high rates (39% vs. 94%)
      - Salsa was the vector! Now—What ingredient? Green onions
  - Cause → Effect

The Epidemiologic Approach

- Analytic Epidemiology:
  - Association: Characteristic is associated with those contracting a particular disease:
    - Demographics (age, sex, race, etc.)
    - Constitutional factor (blood ABO class/ immune status)
    - Behavioral acts (sex, smoking, drugs, salsa)
    - Circumstance (living near a toxic waste dump)
  - Epidemiologic studies are either experimental or observational
  - Experimental Studies:
    - Investigator determines through controlled process the exposure for each individual (clinical trial) or community (community trial) then tracks over time to detect the effects of the exposure
    - EG: Participants are randomly assigned to a study or control group, followed over a period of time and then compared for differences (sample of smokers randomly separated into 3 cessation programs: “Cold Turkey;” NRT, and NRT + Support Group—At the end of same amount of time, which has lowest rates of smokers?)

The Epidemiologic Approach

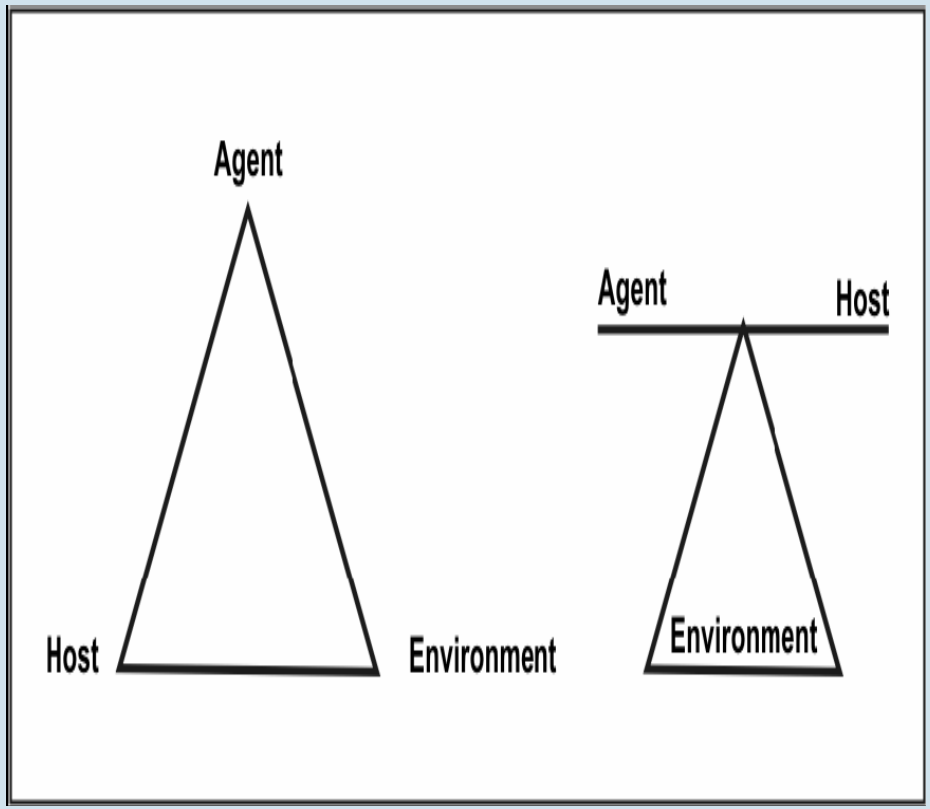
- Analytic Epidemiology:
  - Observational Studies:
    - Simply observes the exposure and disease status of each study participant
    - Either cohort, case-control, or cross-sectional
    - Cohort Study:
      - Follow individuals exposed and non-exposed and determine which group gets this disease; if exposed develops disease, exposure is associated with that disease *note: differs from experimental in that the researcher doesn't assign exposure
      - Framingham (Mass) study assessing exposures to risk factors and prevalence of heart disease: This is a prospective cohort study because it employs follow-up
      - Retrospective cohort studies are performed *after* both exposure and disease have occurred and are useful at assessing commonalities in exposed groups

The Epidemiologic Approach

- Analytic Epidemiology:
  - Observational Studies:
    - Cohort Study:
      - Case Control Study:
        - » People with a certain Dz (case persons) are enrolled in a study along with people without that Dz (controls)—comparisons of exposure are made between the groups to help ID the exposure
      - Cross Sectional Study:
        - » A sample of persons is enrolled in the study—their Dz is the same but their characteristics might be different. Then exposures and health outcomes are measured and compared
        - » Eg: HIV clients who use crystal methamphetamine have faster rates of immune decline and AIDS progression

The Epidemiologic Approach

- Concepts of Disease Occurrence:
  - Diseases don't occur randomly—They occur as a result of an exposure to risk factors which may or may not be random
  - Causation:
    - Epidemiological Triad:

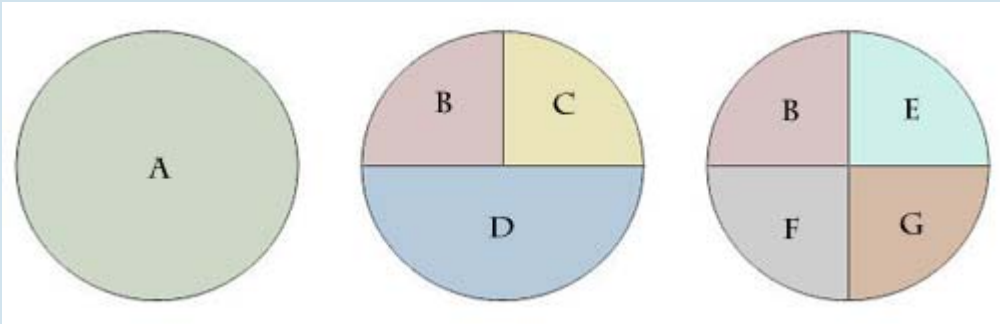


The Epidemiologic Approach

- Causation:
  - Agent: Infectious microorganism or pathogen (virus, bacterium, parasite, microbe); its presence alone may not cause Dz (pathogenicity and dose are also salient)
  - Host: A human who can get the Dz; there are a multitude of factors which can influence whether a host becomes infected
  - Environment: These are extrinsic factors affecting the agent and the opportunity for exposure:
    - Hep A contaminated green onions → Eaten at Taco Bell®→ Hepatitis A
      Agent Environment Host

The Epidemiologic Approach

- Causation:
  - Component Causation and Causal Pies:
    - Designed to help explain the relationships in non-infectious Dz
    - Causative etiologies (each called a **component cause**) are "slices of pie;" the completed pie causes the Dz (**sufficient cause**); often, there are different combinations of component causes leading to sufficient cause. Those that overlap are **necessary causes**; the Dz does not occur without it.
    - Rothman Causal Pie:



The Epidemiologic Approach

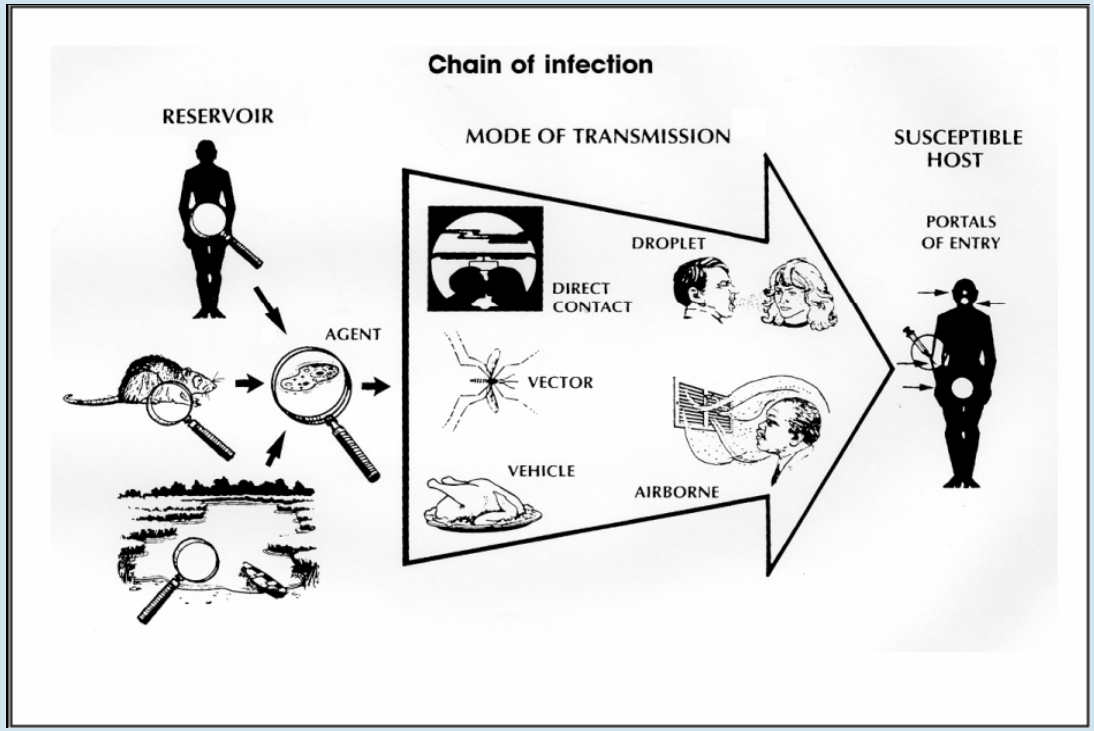
- Component Causation and Causal Pies:
  - A component cause might have intrinsic host factors as well as the agent and environmental factors of the agent-host-environmental triad
  - A single component is rarely responsible for a Dz (exposure to *Pneumocystis carinii* rarely results in actual PCP—but it is a necessary cause and in an AIDS client, becomes a sufficient cause)
  - Smoking is neither necessary or sufficient by itself (persons who smoke don't all develop lung CA and not all persons who have lung CA were smokers). Extrapolating further, the correct model for lung CA would have to include a "pie" that does not include smoking as a component
    - » We do not have to ID all of the component causes to implement public health strategy—if smoking is a component in a large number of the causal pies, then we know smoking is a "targetable" risk factor

The Epidemiologic Approach

- Natural Hx & Spectrum of Dz:
  - Most diseases have a characteristic natural Hx (untreated HIV takes up to 10 years to cause AIDS):
    - Exposure/ Factor Accumulation →
    - Pathological Change (**incubation (infection) or latency (chronic Dz) period**) →
    - Disease Presentation (symptoms)
  - Most screening methods target the incubation/latency periods
  - Spectrum of Dz: Some individuals will develop mild to severe symptoms of a Dz or it may be fatal (always ends in **recovery, disability, or death**)
    - Infectivity: Proportion of persons exposed who become infected
    - Pathogenicity: Proportion of persons infected who develop clinical Dz
    - Carriers: Individuals who are infected and who can infect others but who do not develop clinical Dz

The Epidemiologic Approach

- Chain of Infection:
  - Transmission occurs when the agent leaves its **reservoir** or host through a **portal of exit**, is conveyed by some **mode of transmission**, and enter an appropriate **portal of entry** to infect a **susceptible host**:
  - Chain of Infection:



The Epidemiologic Approach

- Reservoir:
  - Habitat in which the agent normally lives, grows, and multiples (may or may not be the source)
  - Human Reservoirs:
    - Dz transmitted from one person (reservoir) to another (host) (STIs, MMR, Strep. Infections, rhinovirus, etc.)
    - May or may not show effects of an illness
    - Passive carriers are constantly asymptomatic and may not know they are transmitting
    - Incubatory carriers transmit during the time prior to symptom presentation
    - Convalescent carriers have recovered from the illness and are still able to transmit (Typhoid Mary)
    - Remember, asymptomology INCREASES the likelihood of transmission

The Epidemiologic Approach

- Typhoid Mary (Mary Mallon):

The Epidemiologic Approach

- Reservoir:
  - Animal Reservoirs:
    - Zoonosis: Dz transmission from a vertebrate animal to human host
    - Many Dz do have known animal reservoirs (anthrax, plague, rabies, West Nile encephalitis); some are suspected (HIV, Ebola, SARS) but animal reservoirs not yet ID
  - Environmental Reservoirs:
    - Plants, soil, and water also serve as reservoirs
    - Fungal agents cause histoplasmosis and can live in soil; Legionnaires Dz often caused by water contaminated with *Legionella pneumophilia* in cooling towers

The Epidemiologic Approach

- Portal of Exit:
  - Path in which a pathogen leaves its host; usually corresponds to its site of infection (cholera in the feces; *Mycobacterium tuberculosis* in the respiratory tract; schistosomes through urine)
- Modes of Transmission:
  - Direct:
    - Direct Contact: Occurs through skin-to-skin contact, kissing, intercourse
    - Droplet Spread: Spray with relatively large, short-range aerosols produced by sneezing, coughing, talking, singing, laughing (pertussis/ meningococcal infection)
  - Indirect:
    - Airborne: Carried by very small dust or droplet nuclei in the air which may last long periods of time and be blown great distances (TB, measles)
    - Vehicles: Food, water, and biologic products, and fomites (Hep A, B, C, E)
    - Vectors: Mosquitoes, ticks, fleas carry and cause infection (*Shigella*, plague, malaria).

The Epidemiologic Approach

- Portals of Entry:
  - Manner in which a pathogen enters a susceptible host, through tissues in which the pathogen can multiply or a toxin act
  - Often use the same manner in which they exit (influenza virus: respiratory tract)
  - Contact with contaminated fecal particles in fecal-oral (Hep A; *E. coli* septicemia); Skin (hookworm); Mucous Membranes (syphilis), and Blood (HIV/Hep B/C)
- Host:
  - Final link in the chain of infection
  - Susceptibility depends on genetic and constitutional factors (immunity, factors limiting infection/pathogenicity)
  - Specific immunity describes antibodies directed at specific agents (phagocytosis of bacteria); obtained through vaccination, formation post-exposure, passive (mother-to-infant), or transplacental

The Epidemiologic Approach

- Implications for Public Health:
  - Knowing portals of entry/exit or destroying the agent at its source allow us to aim public health initiatives at stopping specific causes (treating a client w/ ATBx, covering or sterilizing contaminated soil, etc.)
  - We can also aim interventions at the mode of transmission (cleaning water supply of feces or isolating someone with TB; spraying large surface areas with pesticides)
  - We also protect portals of entry (gloves, masks, wearing long pants to prevent Lyme disease from tick bites
  - Protection of the host's defenses also essential: Vaccinations, prophylactic use of antimarial Rxs to prevent malaria from taking root
  - Protecting against a susceptible host can also be done through **Herd Immunity**, ensuring the majority of a population is not susceptible to a certain disease makes the pathogen less likely to "find" those individuals who are susceptible (if 85%-90% of a population is vaccinated against measles and rubella, the majority are protected).
  - The problem with this herd immunity concept is that economic, psychosocial, and other factors influence the number of individuals protected in a particular population (3rd world Countries and vaccinations)

The Epidemiologic Approach

- Epidemic Disease Occurrence:
  - Level of Disease:
    - Endemic Level: The usual amount of prevalence of a disease within a particular community; baseline is often the expected level
    - Usually, only deviations in the endemic level warrant investigation
    - **Sporadic** disease occur infrequently/irregularly (rabies, plague, polio)
    - **Hyperendemic** refers to persistent, high levels of disease occurrence in a community
    - **Epidemic** is when there is a sudden increase in the number of cases of a disease higher than its endemic level within a population (**Outbreak** is similar but describes an epidemic in a specific certain geographic location)
    - **Cluster** refers to aggregation of cases grouped in place and time in greater numbers than expected, even if not known
    - **Pandemic** is an epidemic which has spread over several continents or countries (HIV/AIDS)

The Epidemiologic Approach

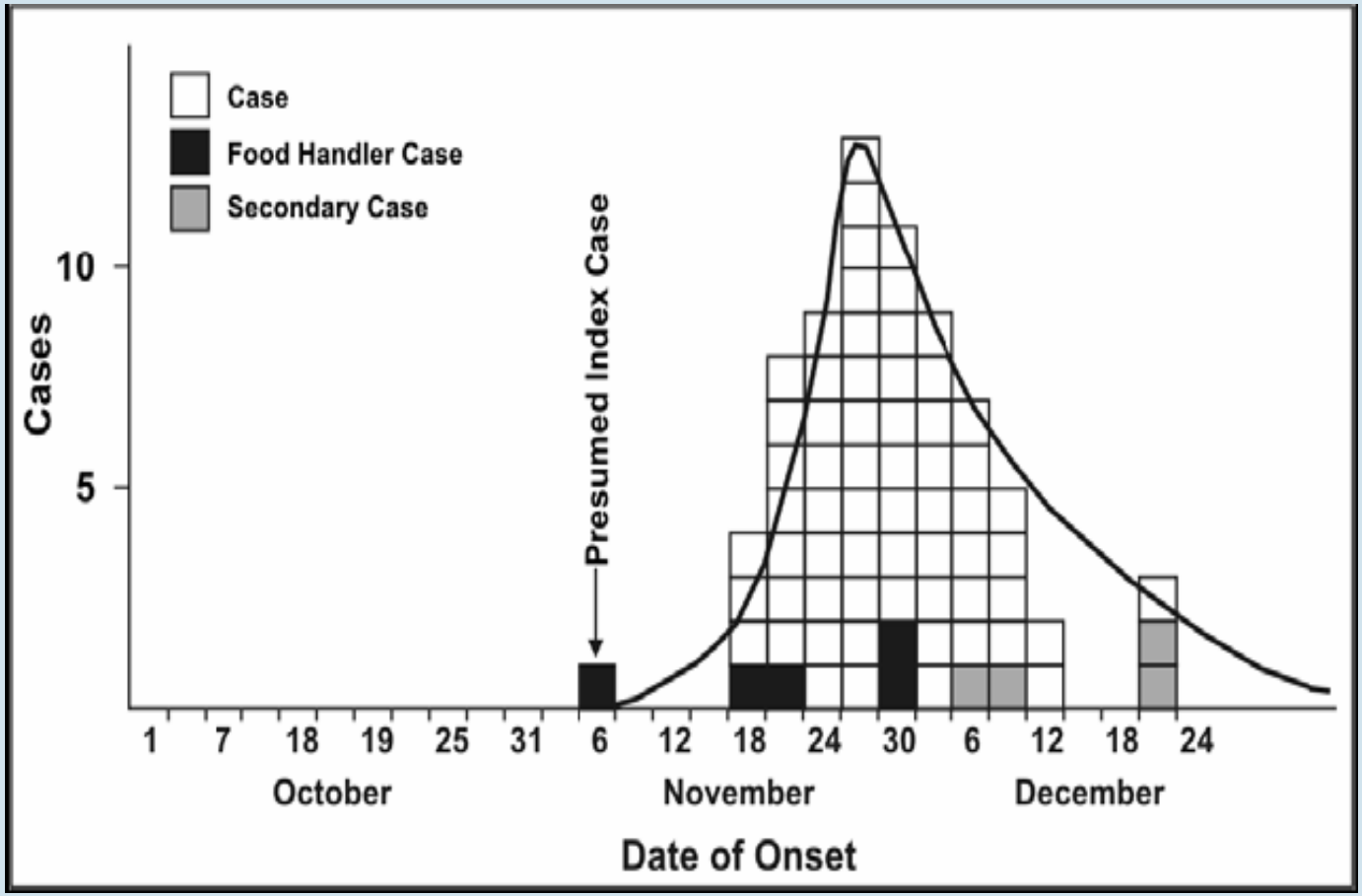
- Epidemic Disease Occurrence:
  - Epidemics result when there is an adequate number of agents and hosts and the agent is effectively conveyed from a source to susceptible host; results from:
    - Recent ↑ in amount of virulence in an agent
    - Introduction of an agent into a new area
    - Enhanced modes of transmission so more susceptible people are exposed
    - Change in the susceptibility of a host response to agent
    - Factors increasing host exposure or involve introduction through new portals of entry
  - Epidemics do not solely result from infections—obesity, diabetes, and CAD are epidemics in the US

The Epidemiologic Approach

- Epidemic Patterns:
  - Common Source Outbreaks: A group of individuals all exposed to the same toxin; if everyone becomes ill within the same incubation period, it is a point-source outbreak
  - Examples include outbreaks of Hep A infection in PA and leukemia in residents exposed to the A-Bomb attack in Hiroshima

The Epidemiologic Approach

- Point-Source Outbreak Graph:



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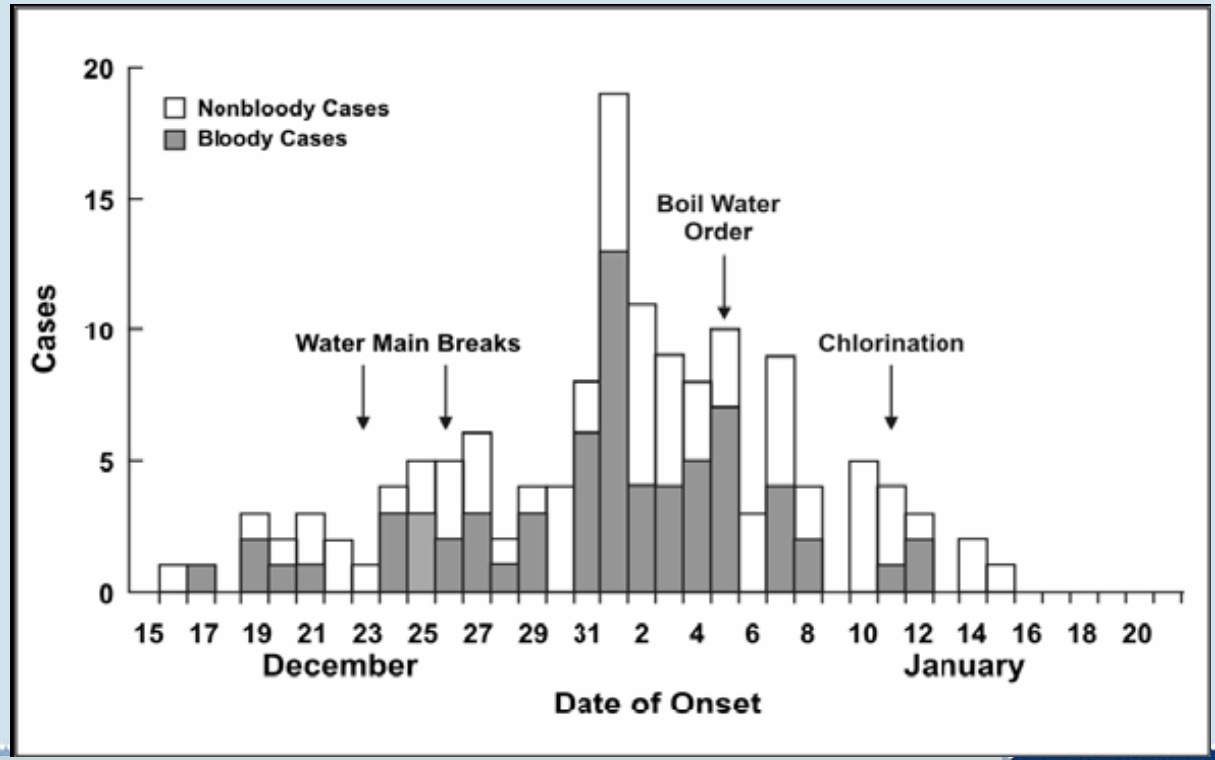
– In continuous common-source outbreaks, the range of exposures and range of incubation flatten and widen the peaks of the epidemic curve:



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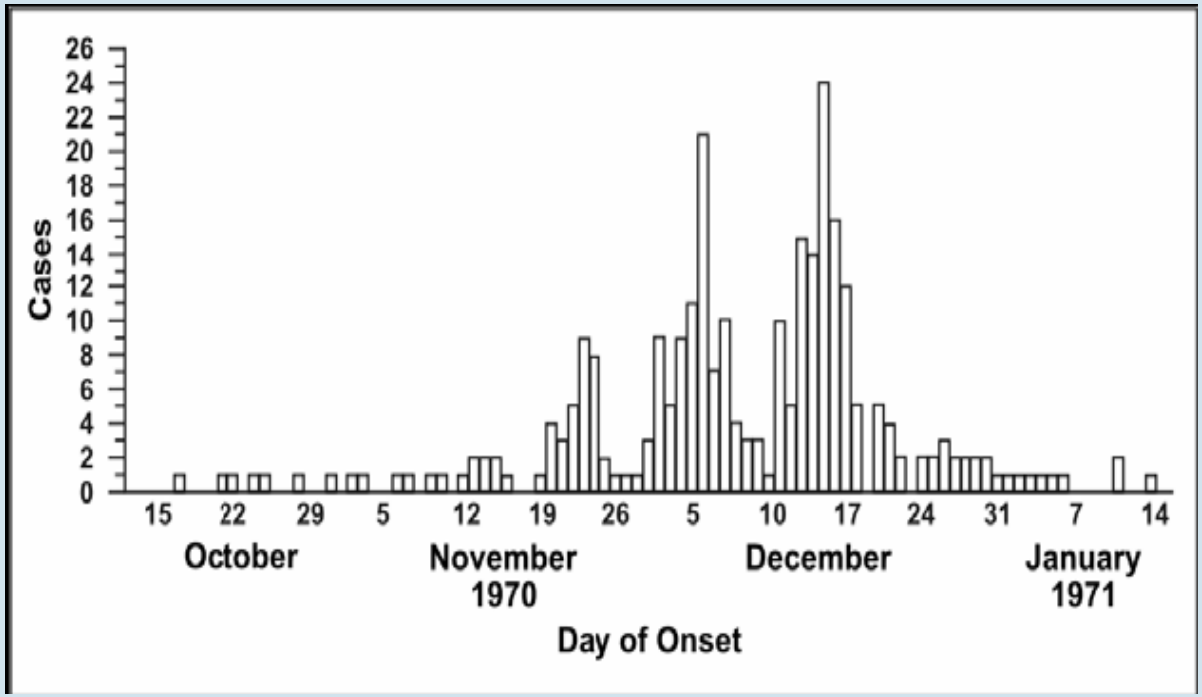
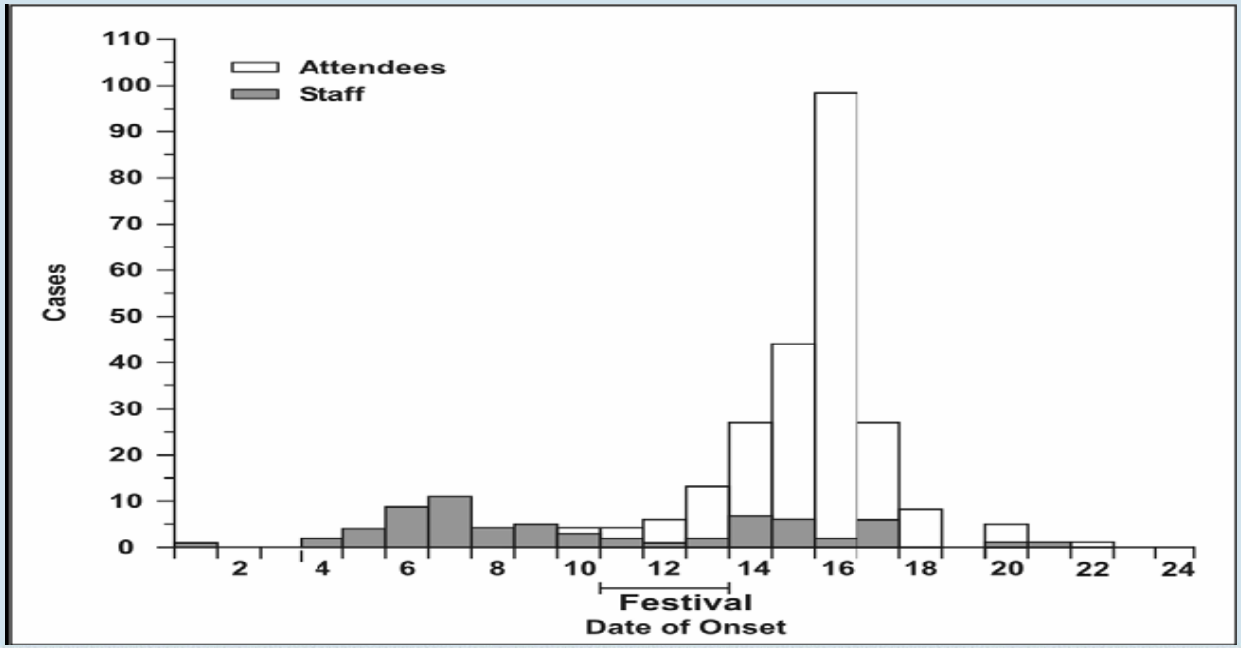
– Propagated Outbreaks results from person-to-person transmission, are vehicleborn (HIV w/ sharing needles), or vectorborne (yellow fever w/ mosquitos)



The Epidemiologic Approach

- **Mixed epidemics** share features of both common-source and propagated epidemics.
- One example was transmission of shigellosis among 3,000 women attending a music festival
- These women then propagated *Shigella* from person-to-person contact: Staff → Attendees:



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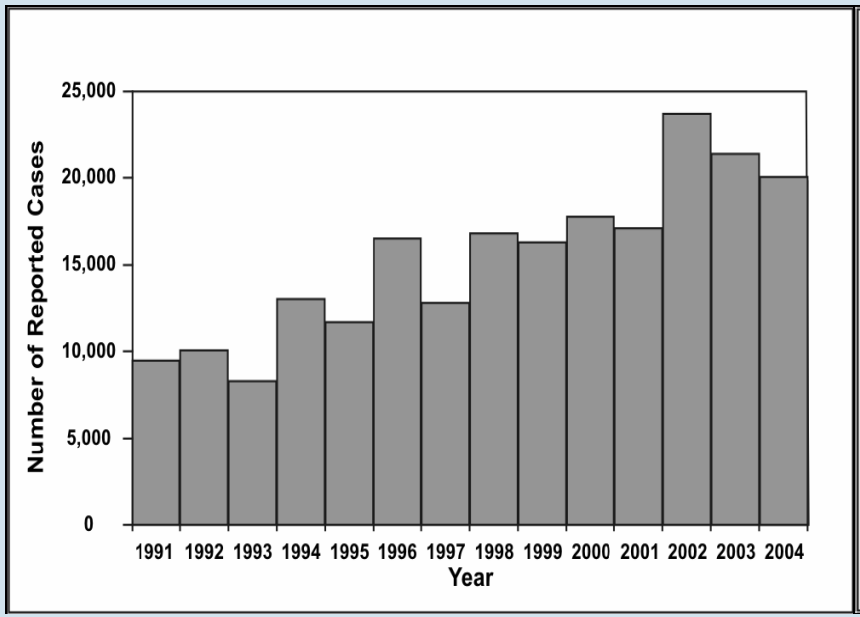
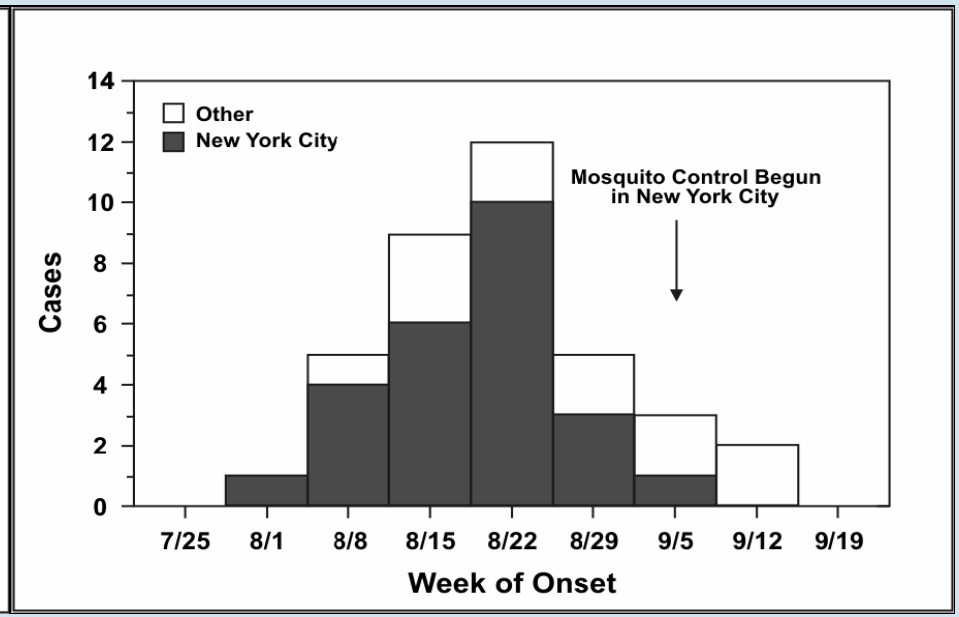
- Some epidemics are neither common-source or propagated
- Zoonotic or vectorborne disease: sufficient interaction occurs between host → vector → human:





The Epidemiologic Approach

- Summary:
  - Epidemiology includes the study of frequency, patterns, and causes of health-related states or events in populations
  - Epidemiologists systematically assess what, who, where, when, and why of these events
  - Core epidemiologic tasks include public health surveillance, field investigation, research, evaluation, and policy development
  - Epidemiologists compare diseased and non-diseased samples to generate hypotheses about disease factors and causes