

MMG 301 Lec. 35 Epidemiology and Bioterrorism

Questions for Today: (consider Med Micro course)

1. What is epidemiology?
2. How is epidemiology important to public health?
3. What pathogens are important in germ warfare and bioterrorism?

Definitions

Epidemiology: the study of the occurrence, distribution, and control of diseases.

Endemic: the low, constant frequency of a disease in a population.

Epidemic: higher than normal frequency of a disease in a population.

Pandemic: Significant increase in frequency of a disease on a continent-wide or world-wide scale.

Carrier: Individual who may not exhibit symptoms, yet carries and passes on to others a disease.

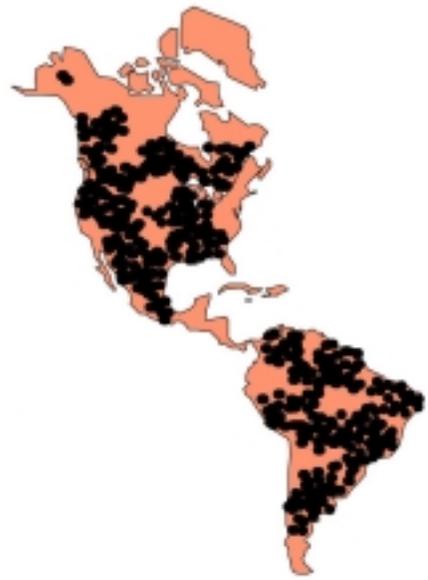
Reservoir: animate or inanimate sites where the pathogen is maintained in nature between outbreaks.



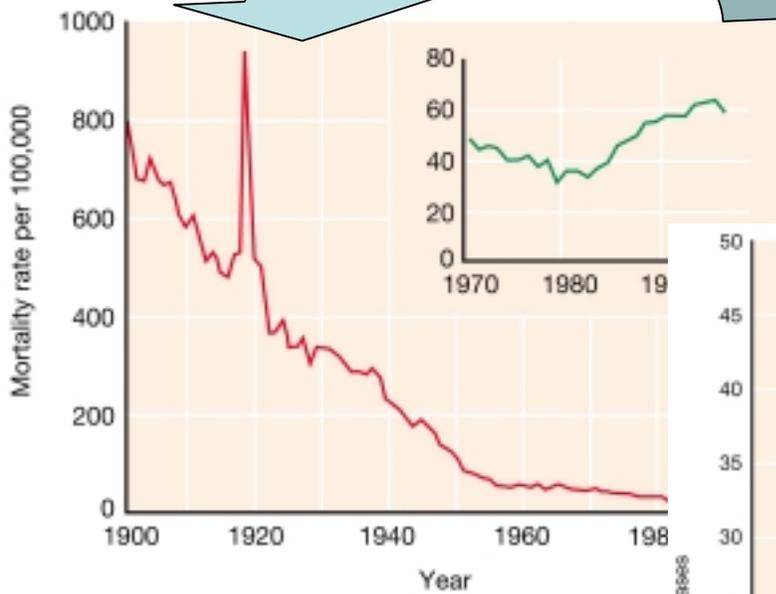
(a) Endemic disease



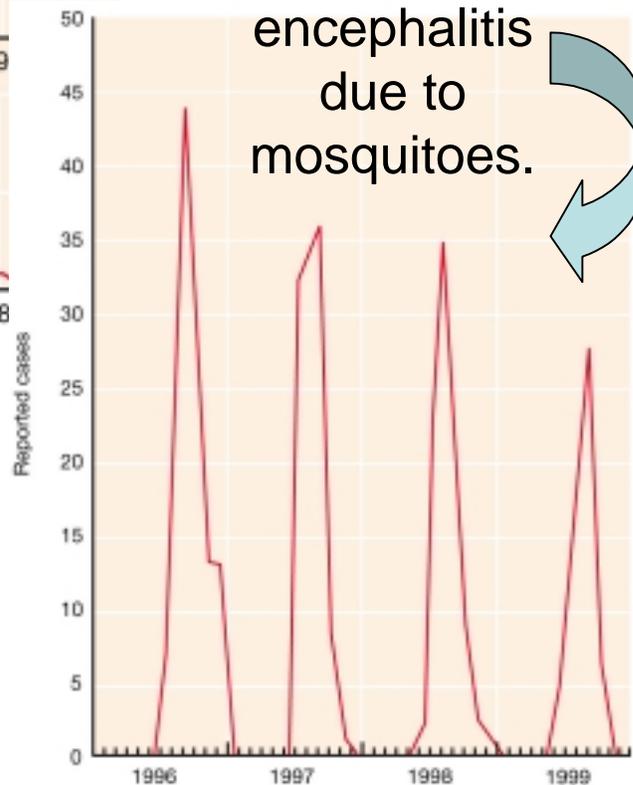
(b) Epidemic disease



(c) Pandemic disease



Spike due to influenza pandemic.
Seasonal incidence of encephalitis due to mosquitoes.



Epidemiologists must collect and analyze data to look for patterns (much like a detective or criminal investigator -- think CSI)

Relationships Between Epidemiologists and Public Health

Typhoid Mary: Mary Mallon, a cook/housekeeper in NYC. Contracted typhoid in 1901, permanently infected in gallbladder, shed pathogen in feces. Dr. George Soper made connection after 28 cases: identified & arrested. Refused offer to surgically remove gallbladder, jailed 3 yr. Agreed to stay out of food service, but disappeared/changed name. Cook at hotels & hospitals, leaving jobs after each new outbreak. Caught after 5 yr and ~200 cases. Jailed 23 years until death.

Cholera in London: Dr. John Snow mapped out cases of cholera in London (1853-1855) versus sources water (2 main distributors). Only 37/100,000 using Lambeth Co. (intake located in Thames above London) vs. 315/10,000 using Southwark & Vauxhall Co. (intake located after raw sewage outlet). Shutting down the latter system resulted in plummet in # cases.

AIDS: Centers for Disease Control and Prevention (CDCP) identified a large number of deaths among homosexual males in Los Angeles in 1981. This observation stimulated research leading to the discovery of HIV.

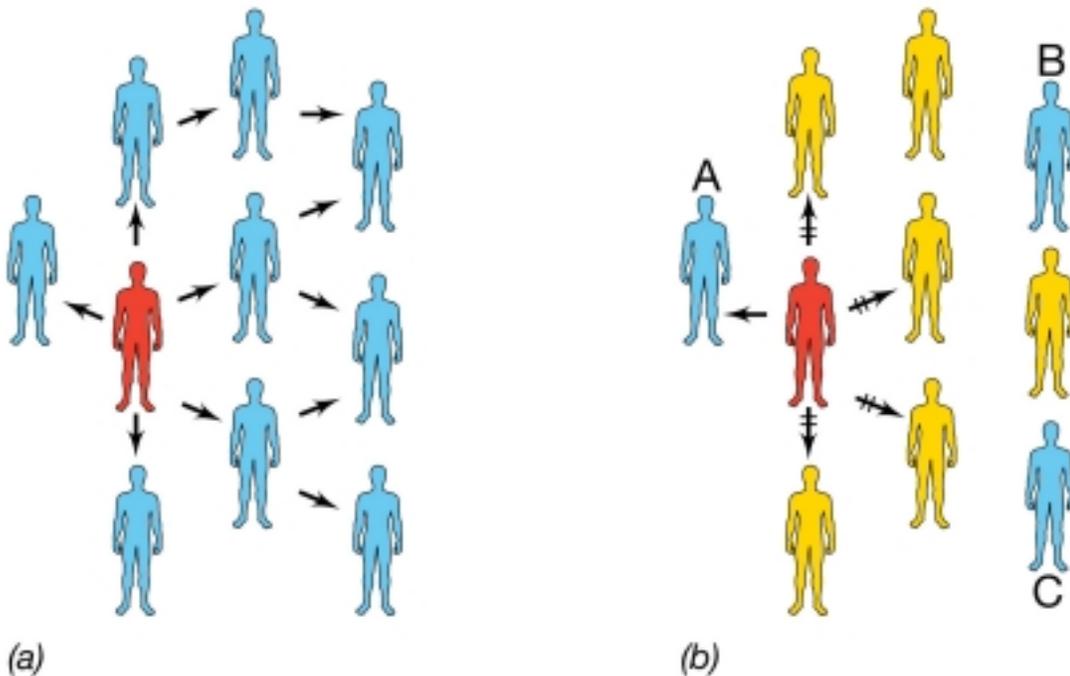
Emerging Diseases: Constant vigilance is used to detect newly emerging diseases and identify the associated pathogen (e.g., Ebola, SARS)

Types of Public Health Measures

- Reporting:
 - Doctors are required to collect data and report specified information to State Health Depts. and the CDCP (see list in book, p.864, if interested).
 - must be within 24 hr for some diseases.
- Reservoir controls:
 - an entire herd may be killed after discovering a single infected individual (e.g., cattle with *Brucella abortus*).
 - large-scale slaughter of animals may occur when some are suspected of carrying a human pathogen (chickens in Japan, cattle/sheep in UK).
 - wild animals are destroyed to prevent infection of domesticated species (bison in Yellowstone, deer with “wasting disease”).
 - eliminate rats (plague), mosquitoes, etc.
- Quarantine:
 - effective approach before antibiotics for scarlet fever, tuberculosis, leprosy.
 - isolation wards are used in hospitals for cholera, plague, typhoid, yellow & relapsing fever.
- Measures involving food/water:
 - inspection of abattoirs and meat processing plants.
 - pasteurization
 - water treatment (e.g., separate storm/sewage systems) **Very Important (damaged by disasters)**

Vaccination:

- effective for animals and humans.
- Diphtheria/tetanus/pertussis (DTP), measles, mumps, rubella, influenza B, polio, chicken pox, hepatitis B, are all common for children/adults.
- in some cases, new vaccines are available every year for new strains.
- herd immunity means that not all individuals need to be vaccinated for the vaccine to be effective.



- can use targeted immunization (Smallpox)
- booster shots are needed for some types of vaccines to be effective

A few more definitions (that I forgot to mention earlier)

Fomite: an inanimate object that can transfer a pathogen from an infected host to a new host.

Zoonosis (*pl. zoonoses*): a disease that occurs primarily in animals, but can be transmitted to humans.

Acute: a short-term infection that exhibits a dramatic onset and typically a rapid recovery.

Incidence: number of individuals exhibiting a disease.

Prevalence: proportion or percentage of people having a disease.

Agglutination: clumping of particles (e.g., result of adding an Ab).

Monoclonal Antibodies: Identical antibodies (exactly the same specificities) that are produced by a clone of B cells (e.g., some autoimmune diseases or created in lab)

Polyclonal Ab: Collection of Ab made by different B cell clones, may recognize different epitopes of the same Ag.

Bacterial Priority Organisms of Bioterrorism

CDCP categorizes biological organisms according to ease of dissemination, mortality rates, and ease of procurement and growth.

Category A: Anthrax, Botulism, Plague, Smallpox, Tularemia, Viral Hemorrhagic fever

- can be easily disseminated or transmitted from person to person.
- result in high mortality rates and have the potential for major public health impact.
- might cause public panic and social disruption.
- require special action for public health preparedness.



Bacillus anthracis

- *Bacillus anthracis* – **anthrax**: Gram-positive, non-motile, spore-forming rod
 - Has three virulence factors
 - Routes of human infection (all can lead to death if untreated): Cutaneous (skin), Inhalation (respiratory tract), Gastrointestinal
- *Clostridium botulinum* – **botulism**
 - Direct ingestion of toxin, wound infection by bacterium
- *Yersinia pestis* – bacterium that causes the **plague**
 - Three forms of infection:
 - Pneumonic plague – infection in lungs
 - Bubonic plague – infection through skin from flea (bubo is a swelling)
 - Septicemic plague – bacteria infect the blood; complication of pneumonic or bubonic
- *Francisella tularensis* - **tularemia**
 - skin ulcers, swollen and painful lymph glands, inflamed eyes, sore throat, oral ulcers, or pneumonia
 - Highly infectious – only 10-50 cells needed for infection
 - *F. tularensis* occurs widely in nature; easy to isolate
 - Inhaled bacteria can cause severe illness quickly

Smallpox – variola virus; transmitted by aerosol or direct contact

- After infection, development of skin rash which progresses to formation of pustules
- Septic shock and toxemia (toxic substances in the blood) can result in fatality rates of up to 30%
- Disease has been **eradicated in the world** (eliminated from US in 1960 by vaccination; WHO begin world-wide effort in 1967 to vaccinate endemic areas, target outbreaks, and quarantine those infected; last natural disease case in 1976; declared success in 1980); factors that aided eradication:
 - Only human reservoir
 - No asymptomatic carriers
 - Short period of infectivity

[Other targets for eradication: polio, leprosy, Chaga's disease, Guinea worm; with syphilis and rabies as candidates]

Measures to combat bioterrorism

- 1972 Biological and Toxic Weapons Convention led to international agreement to forego these weapons.
- Vaccinations
- protective suits, lotions, etc.