Epidemiology

The study of determinants of disease, injury, health conditions in a population, and the application of this study to control health problems.

Public Health during Great Influenza of 1918

- What factors played a role in the high death rate from the 1918 Influenza in the United States (600,000 deaths)?
- What measures could have been taken to better protect public health from the influenza?
- You are a public health officer for the City of Boston. Short of administering an effective vaccine, what steps could you have taken to better protect public health in your city?

Introduction

- Epidemiology: study of distribution and determinants of disease and injury in a population.
- Epidemics of communicable diseases: common throughout history.
- Methods of epidemiology: important tools for public health professionals.

Introduction

- An epidemiologist is to a population as a doctor is to a patient
- Questions asked by epidemiologists: How many are sick? Who is sick? When did they get sick? Where did they get sick? What do the sick have in common?
- Epidemiology has been called **"population medicine."**
- **Endemic Diseases–** diseases that occur regularly in a population as a matter of course
- **Epidemic–** An unexpectedly large number of cases of an illness, specific health-related behavior, or other health-related event in a particular population.

Risk Factors

- Non-modifiable risk factors: things you cannot change
  - Age, gender, family history
- Modifiable risk factors: things you can control, change, modify
  - Biological factors (smoking, cholesterol, blood pressure, physical inactivity)
  - Psychosocial factors (depression, stress, anxiety)

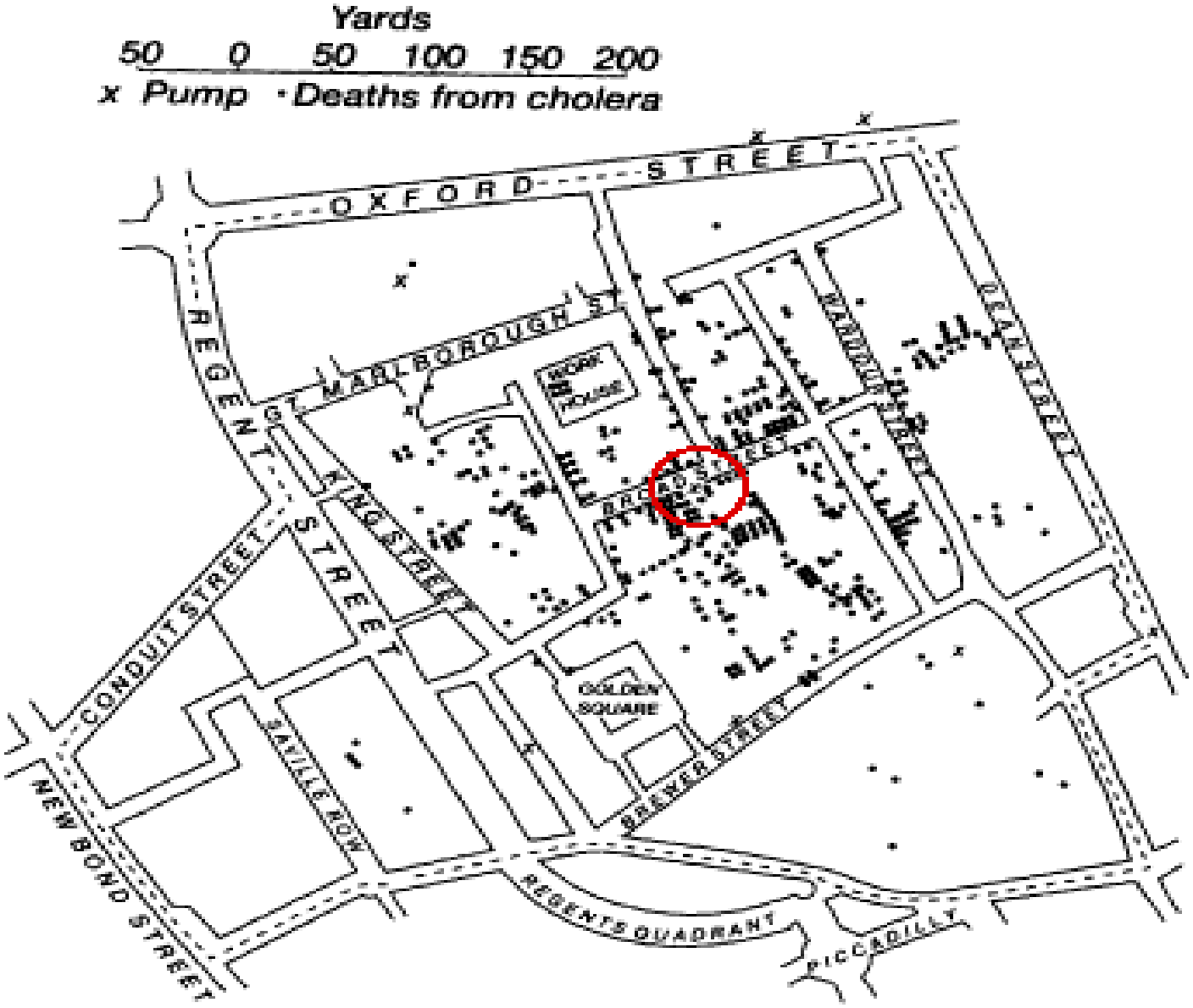
Recent epidemics in the United States

Table 3.1
Recent Epidemics in the United States

Disease	Cases in Previous Years	Epidemic Period	Number of Cases
St. Louis encephalitis	5–72	1975	1,815 [4]
Legionnaires' disease	Unknown	1976	235 [5]
Toxic shock syndrome	11–272	1980	877 [6]
HIV/AIDS	Unknown	1981–2004	944,305 [7]
Lyme disease	Unknown	1990–2004	222,350 [8-10]
Plague	13–19	1983	40 [5]
West Nile virus	Unknown	1999–2005	18,756 [11]
Mumps	231–314	2006	5,423 [12]

Pandemic

- An outbreak of disease over a wide geographical area such as a continent (the influenza pandemic of 1918–1919 killed 25 million people worldwide)

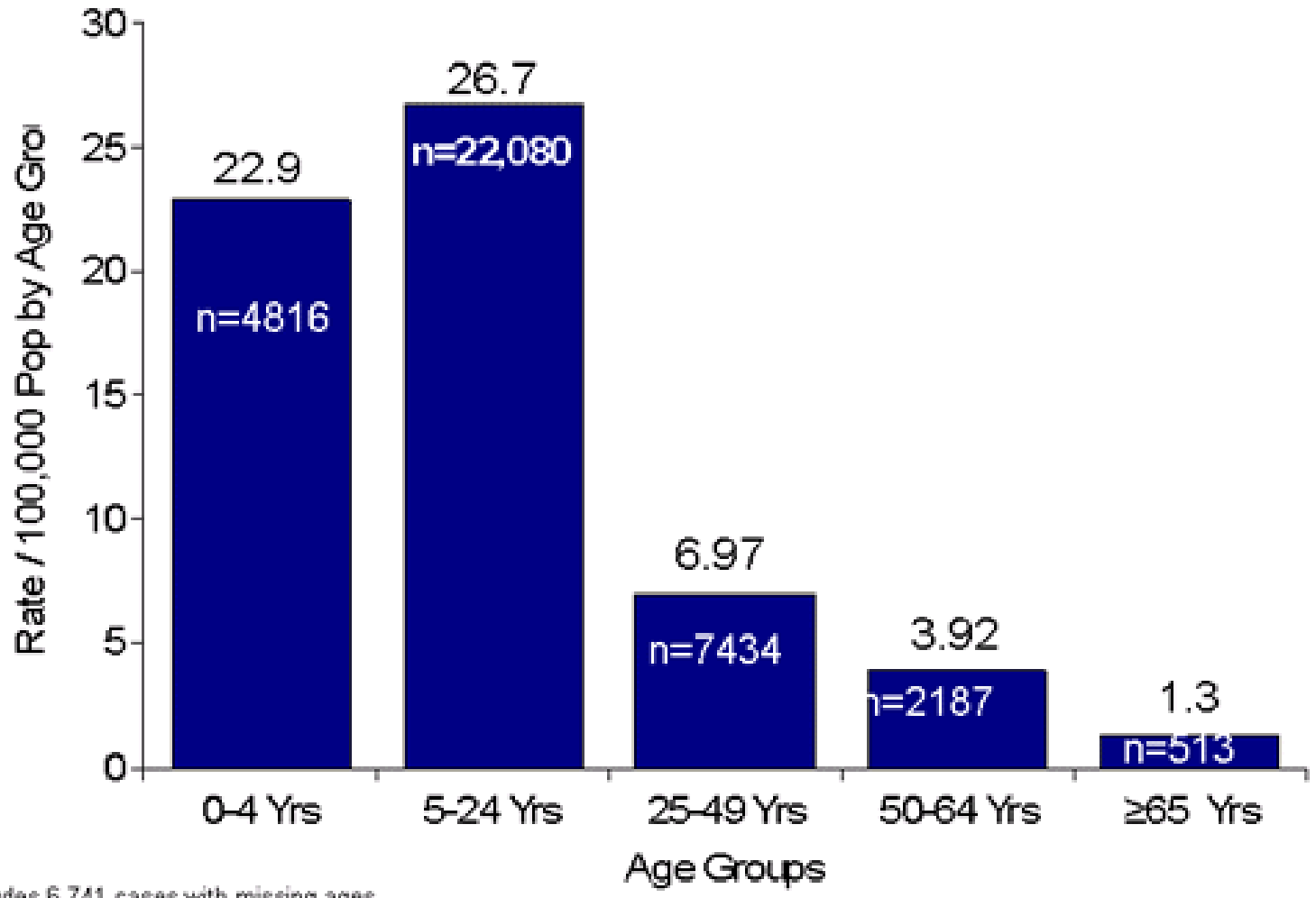

Yards
50 0 50 100 150 200
x Pump · Deaths from cholera
OXFORD STREET
ST. MARLBOROUGH ST.
REGENT STREET
KING STREET
CONDUIT STREET
NEW BOND STREET
SAVILE ROW
GOLDEN SQUARE
BREWER STREET
REGENTS QUADRANT
PICCADILLY
BARBOUR STREET
DEAN STREET
WORK HOUSE

CDC Estimates of 2009 H1N1 Cases and Related Hospitalizations and Deaths from April 2009 - January 16, 2010, By Age Group

2009 H1N1	Mid-Level Range*	Estimated Range *
Cases		
0-17 years	~19 million	~13 million to ~27 million
18-64 years	~33 million	~24 million to ~49 million
65 years and older	~5 million	~4 million to ~8 million
Cases Total	~57 million	~41 million to ~84 million
Hospitalizations		
0-17 years	~82,000	~58,000 to ~120,000
18-64 years	~150,000	~107,000 to ~221,000
65 years and older	~25,000	~18,000 to ~37,000
Hospitalizations Total	~257,000	~183,000 to ~378,000
Deaths		
0-17 years	~1,230	~880 to ~1,810
18-64 years	~8,980	~6,390 to ~13, 170
65 years and older	~1,480	~1,060 to ~2,180
Deaths Total	~11,690	~8,330 to ~17,160

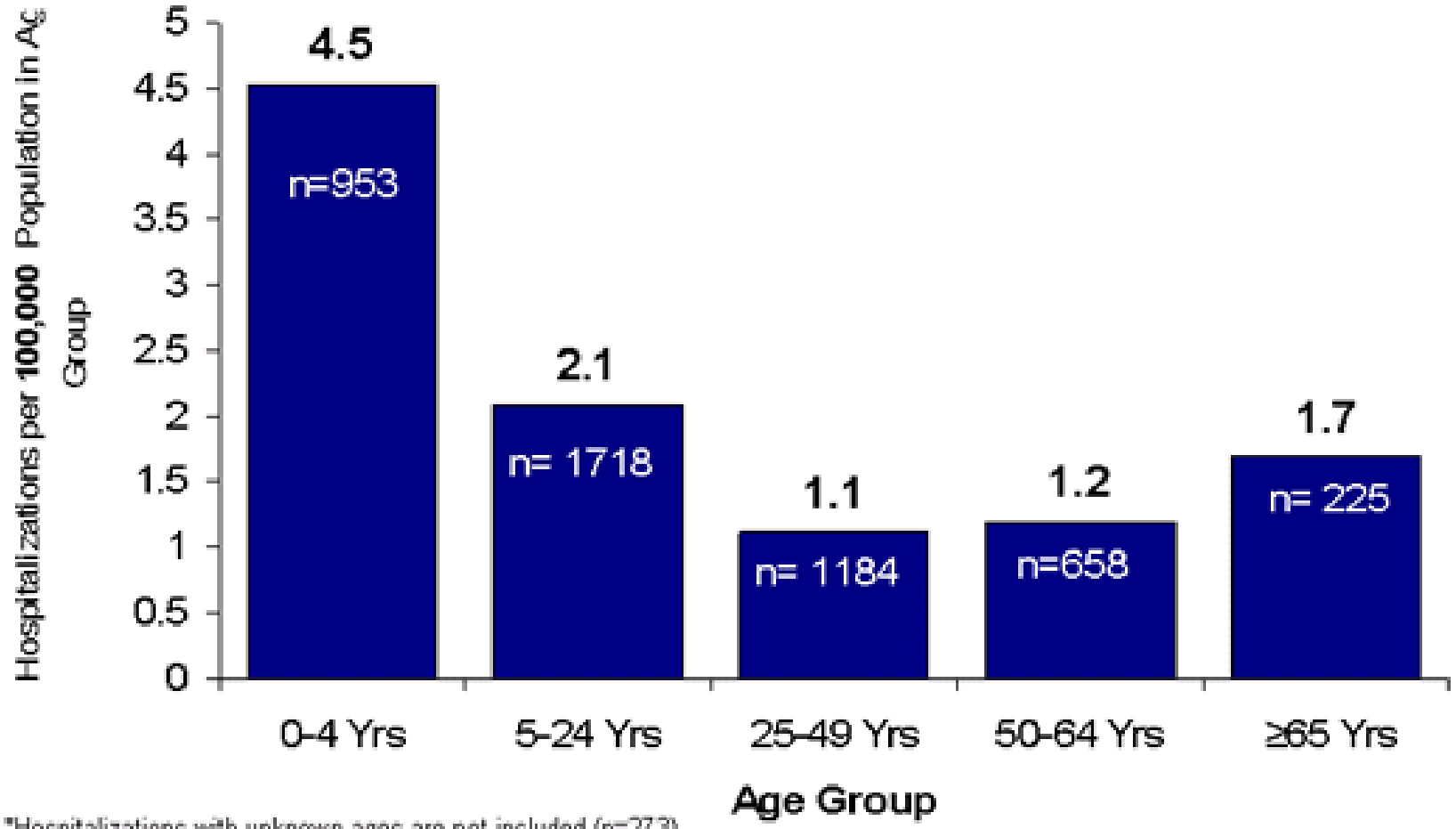
* Deaths have been rounded to the nearest ten. Hospitalizations have been rounded to the nearest thousand and cases have been rounded to the nearest million. Exact numbers also are available.

Novel H1N1 Confirmed and Probable Case Rate in the United States, By Age Group



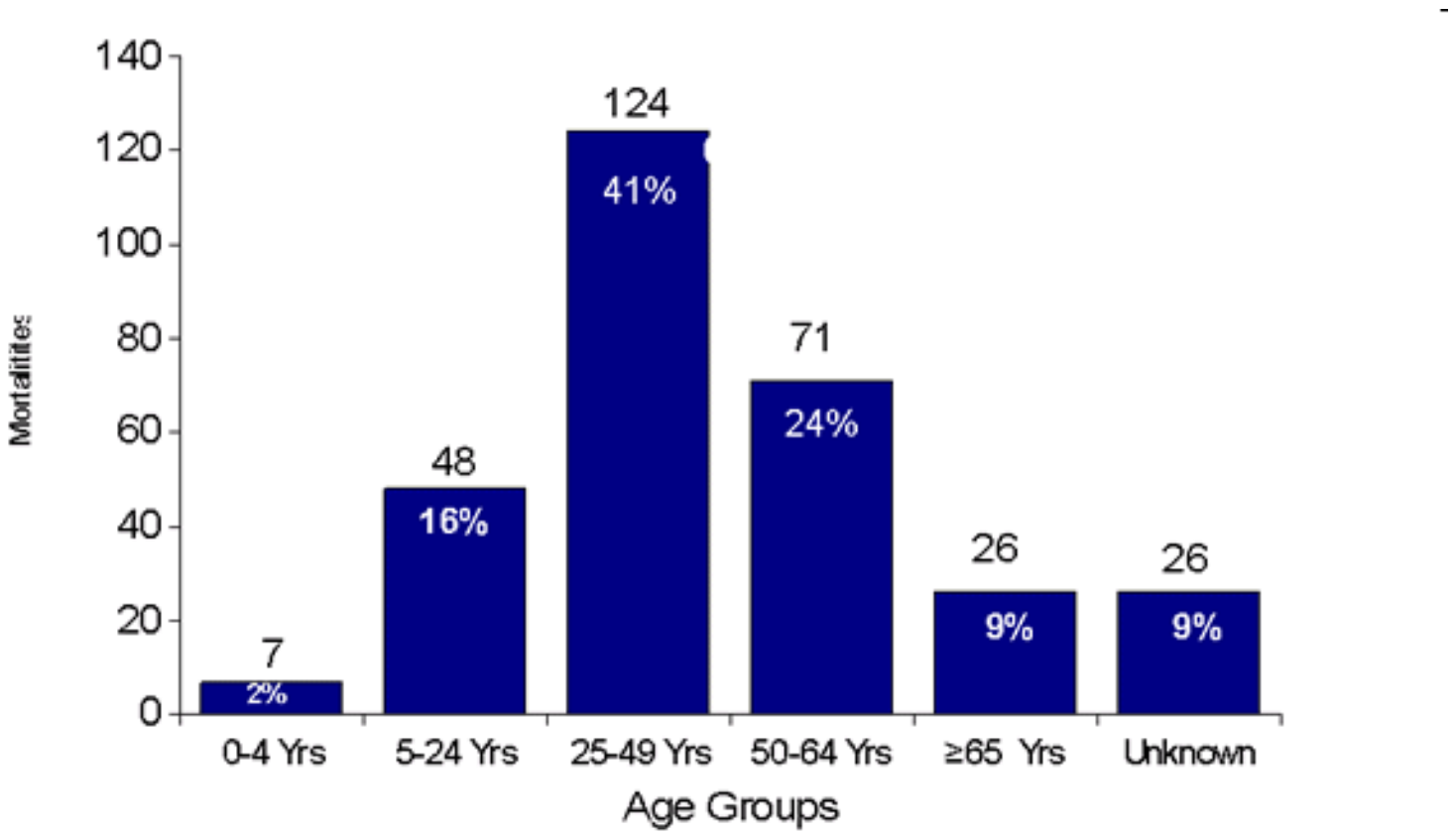
*Excludes 6,741 cases with missing ages.
Rate / 100,000 by Single Year Age Groups: Denominator source: 2008 Census Estimates, U.S. Census Bureau at:
http://www.census.gov/popest/national/asrh/files/NC-EST2007-ALLDATA-R-File24.csv

Novel H1N1 U.S. Hospitalization Rate per 100,000 Population, By Age Group



*Hospitalizations with unknown ages are not included (n=273)
*Rate / 100,000 by Single Year Age Groups: Denominator source: 2008 Census Estimates, U.S. Census Bureau at:
http://www.census.gov/popest/national/asrh/files/NC-EST2007-ALLDATA-R-File24.csv

Novel H1N1 U.S. Deaths, By Age Group

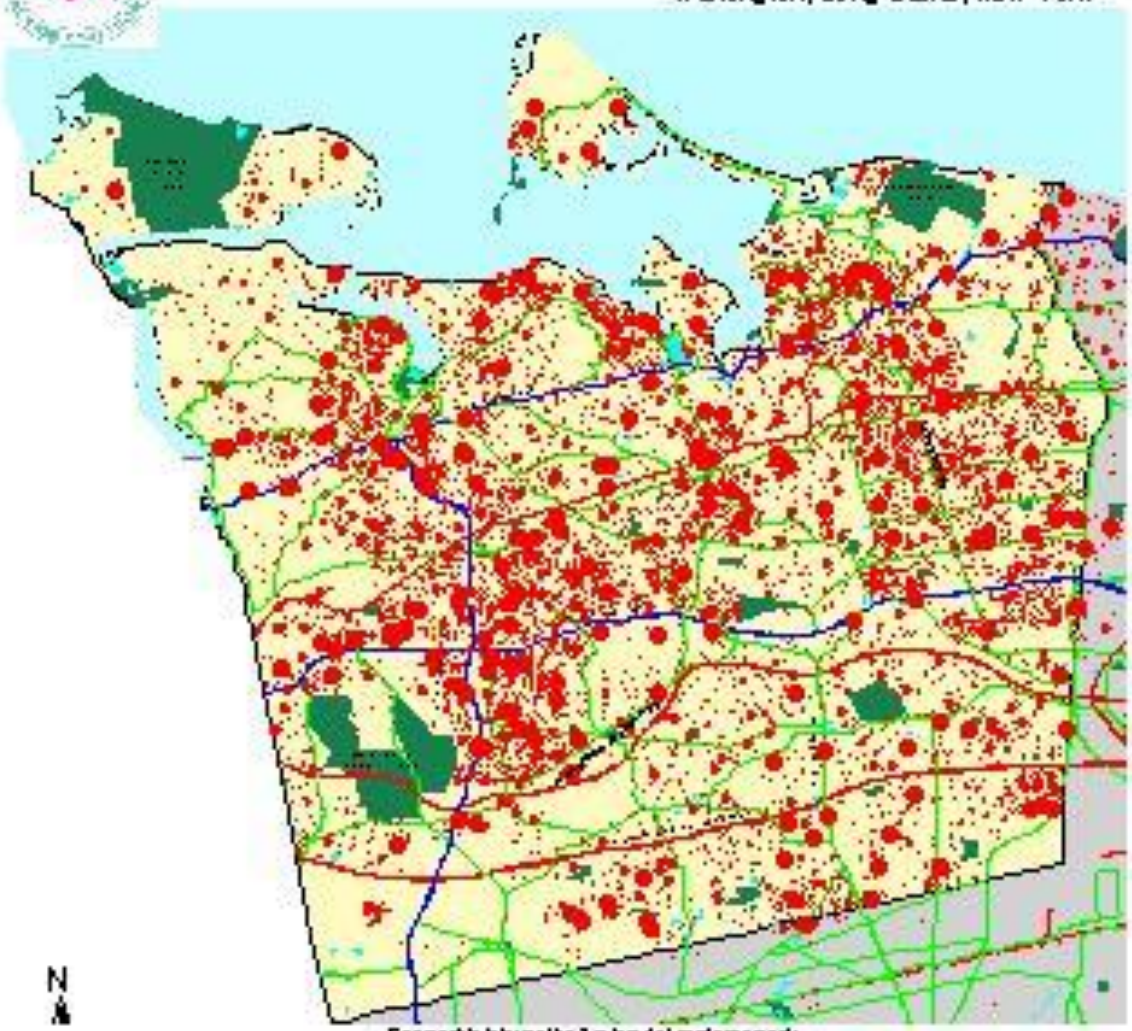


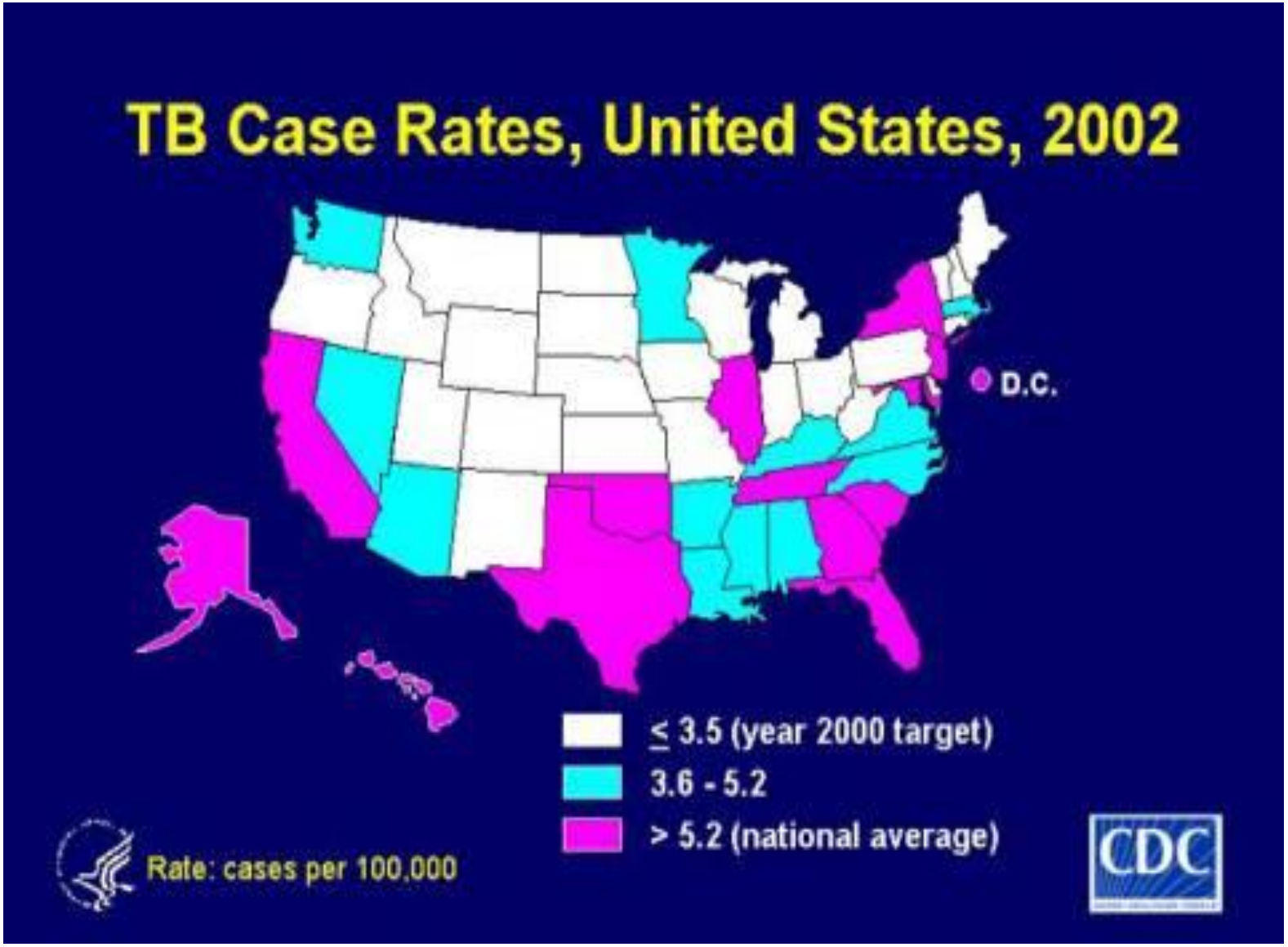
CDC studied the hospital records of 268 patients hospitalized with novel H1N1 flu early on during the outbreak.

Percent of Respondents Ever Having Breast Cancer per ZIP+4

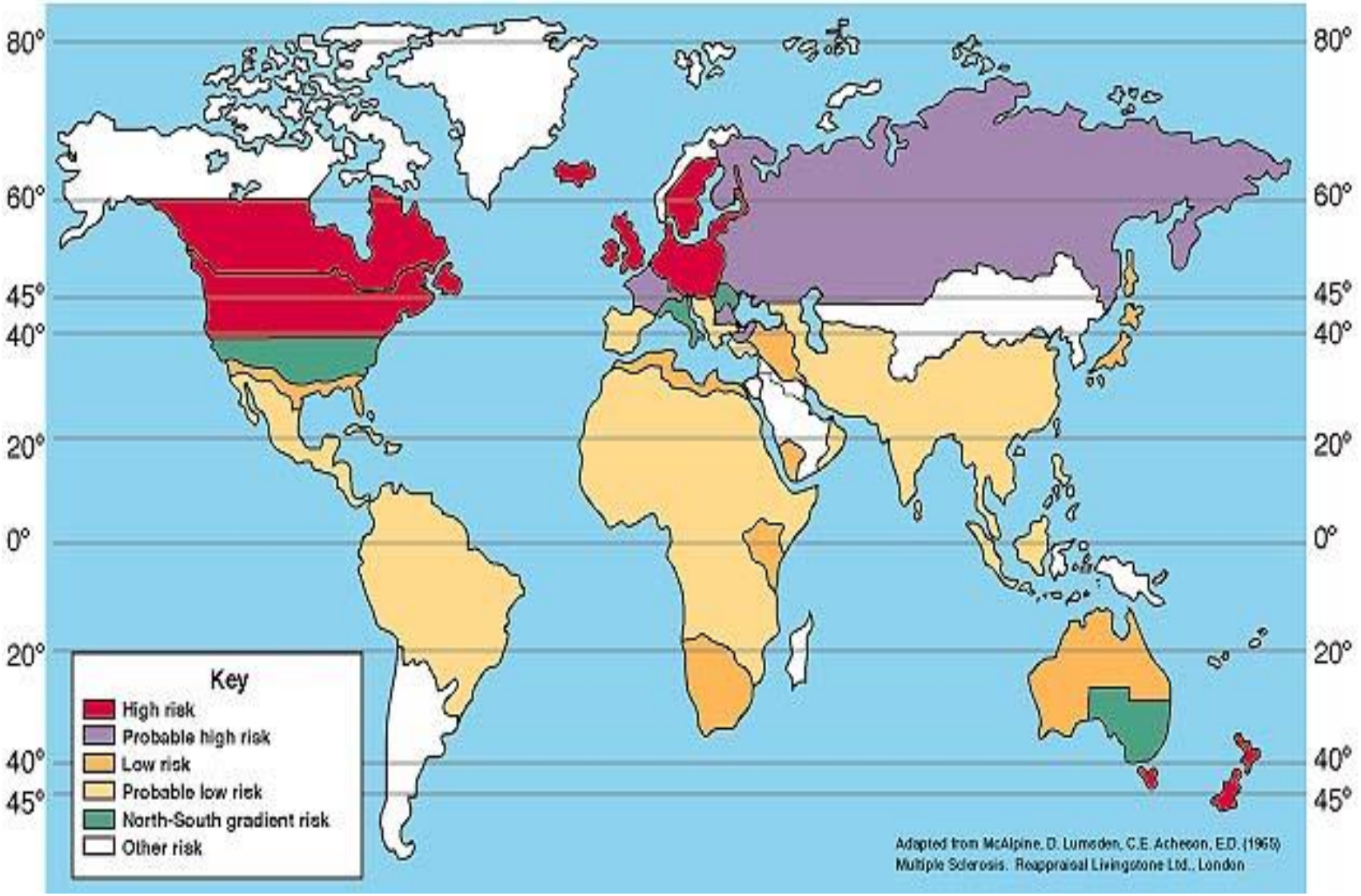
Breast Cancer Prevalence Study 1993-1998

Huntington, Long Island, New York

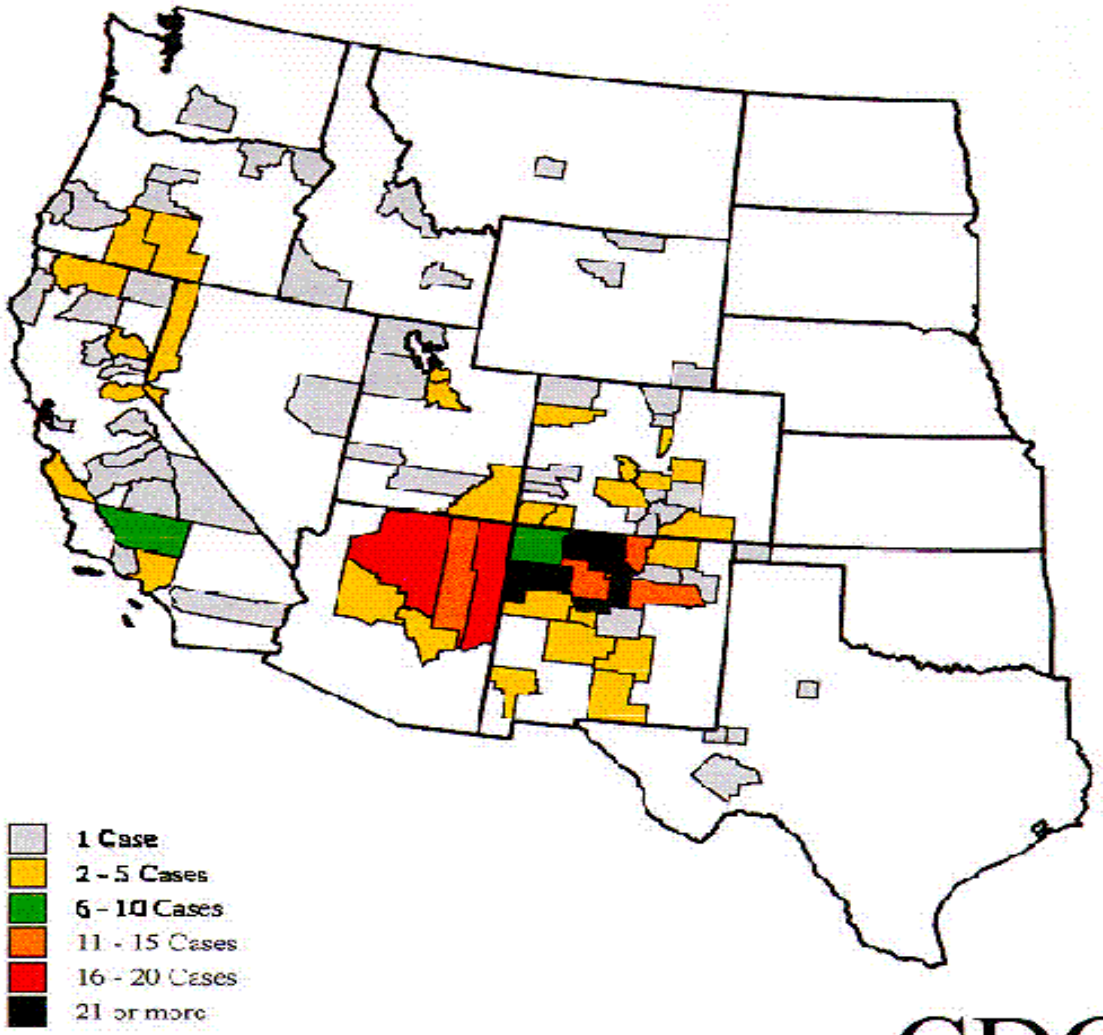



TB Case Rates, United States, 2002
D.C.
≤ 3.5 (year 2000 target)
3.6 - 5.2
> 5.2 (national average)
Rate: cases per 100,000
CDC

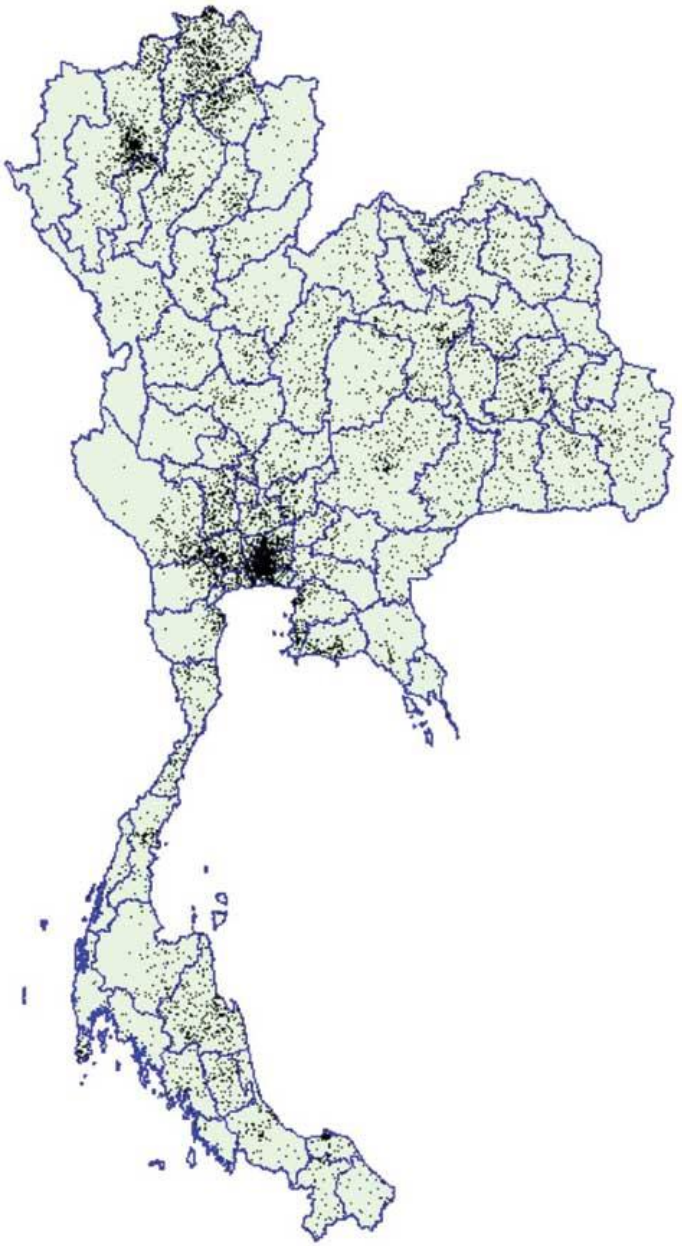
World Distribution of Multiple Sclerosis

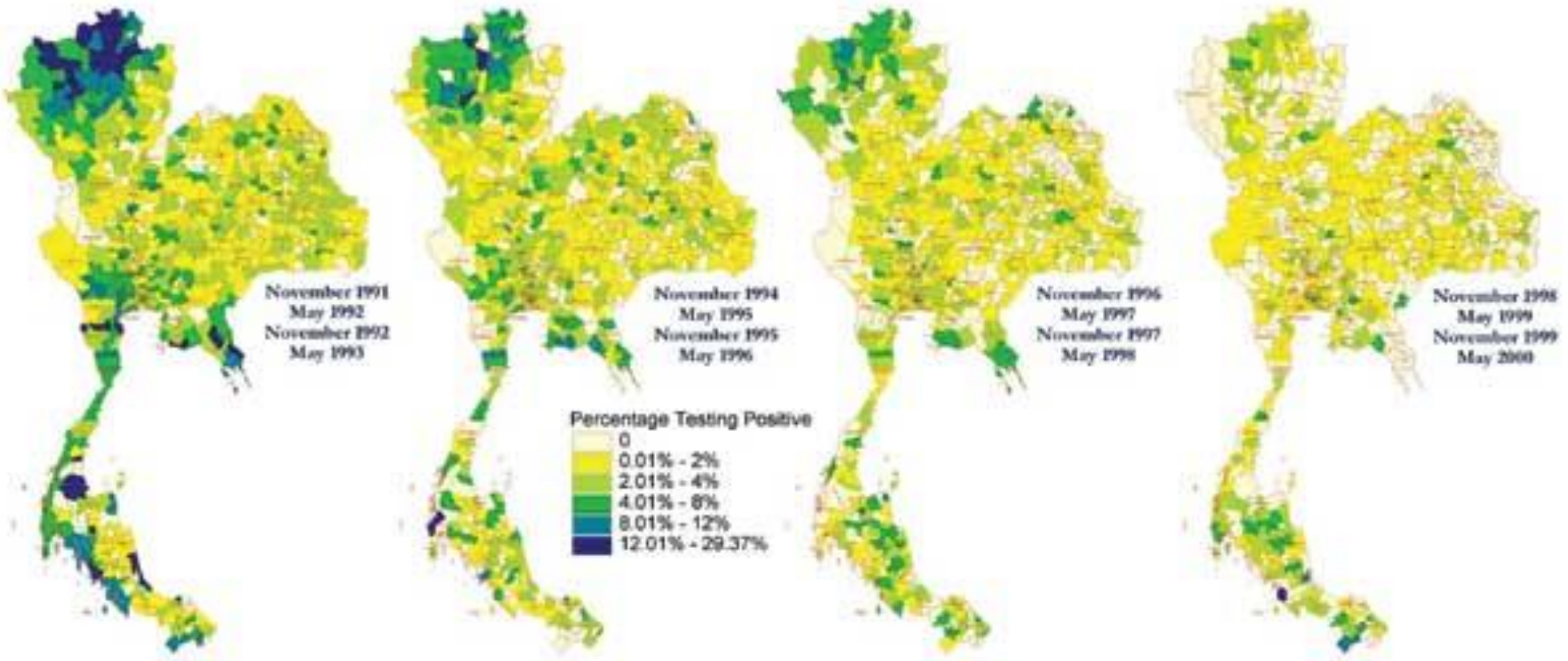


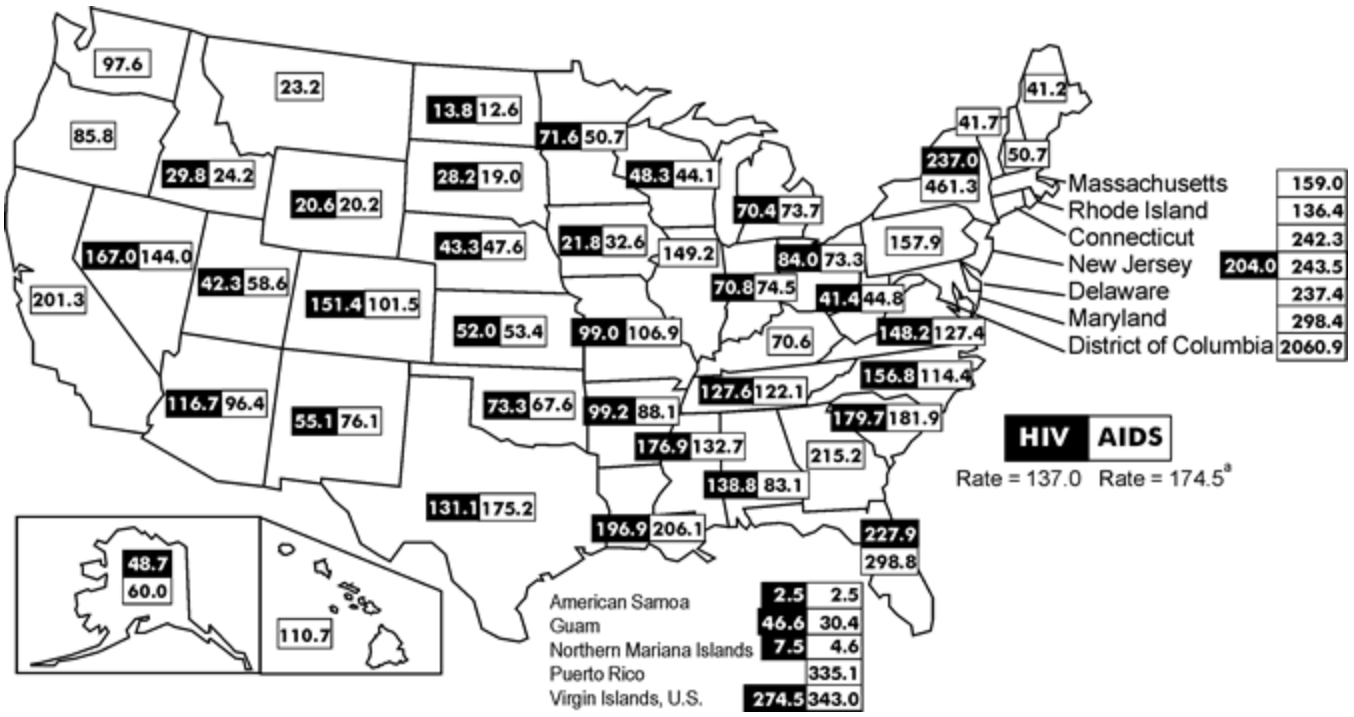
Reported Human Plague Cases by County: U.S., 1970-1997



HIV/AIDS incidence in Males, Thailand, 2001




November 1991
May 1992
November 1992
May 1993
November 1994
May 1995
November 1995
May 1996
November 1996
May 1997
November 1997
May 1998
November 1998
May 1999
November 1999
May 2000
Percentage Testing Positive
0
0.01% - 2%
2.01% - 4%
4.01% - 8%
8.01% - 12%
12.01% - 29.37%


97.6
23.2
13.8 12.6
71.6 50.7
41.2
85.8
41.7
237.0
461.3
50.7
29.8 24.2
28.2 19.0
48.3 44.1
20.6 20.2
70.4 73.7
Massachusetts 159.0
Rhode Island 136.4
Connecticut 242.3
New Jersey 204.0 243.5
Delaware 237.4
Maryland 298.4
District of Columbia 2060.9
167.0 144.0
43.3 47.6
21.8 32.6
149.2
84.0 73.3
157.9
42.3 58.6
70.8 74.5
41.4 44.8
201.3
151.4 101.5
52.0 53.4
99.0 106.9
70.6
148.2 127.4
156.8 114.4
116.7 96.4
73.3 67.6
127.6 122.1
55.1 76.1
99.2 88.1
179.7 181.9
HIV AIDS
Rate = 137.0 Rate = 174.5[a]
176.9 132.7
215.2
138.8 83.1
131.1 175.2
196.9 206.1
227.9
298.8
48.7
60.0
110.7
American Samoa 2.5 2.5
Guam 46.6 30.4
Northern Mariana Islands 7.5 4.6
Puerto Rico 335.1
Virgin Islands, U.S. 274.5 343.0

Importance of Rates

- Epidemiologists use rates to describe occurrence and spread of disease and health problems.
- Three important rates: birth rate, death rate, morbidity rate.
- Types of morbidity rate:
  - Incidence rate: new cases of disease / population
  - Prevalence rate: new, old cases / population
  - Attack rate: special incidence for single outbreak in a population, expressed as %.

3 Important Kinds of Rates

$$\text{Natality (birth) rate} = \frac{\text{No. of live births to residents in an area in a calendar year}}{\text{Population in the area in the same year}}$$

$$\text{Morbidity (disease) rate} = \frac{\text{No. of cases of residents with illness in an area in a calendar year}}{\text{Population in the area in the same year}}$$

$$\text{Mortality (fatality) rate} = \frac{\text{No. of deaths to residents in an area in a calendar year}}{\text{Population in the area in the same year}}$$

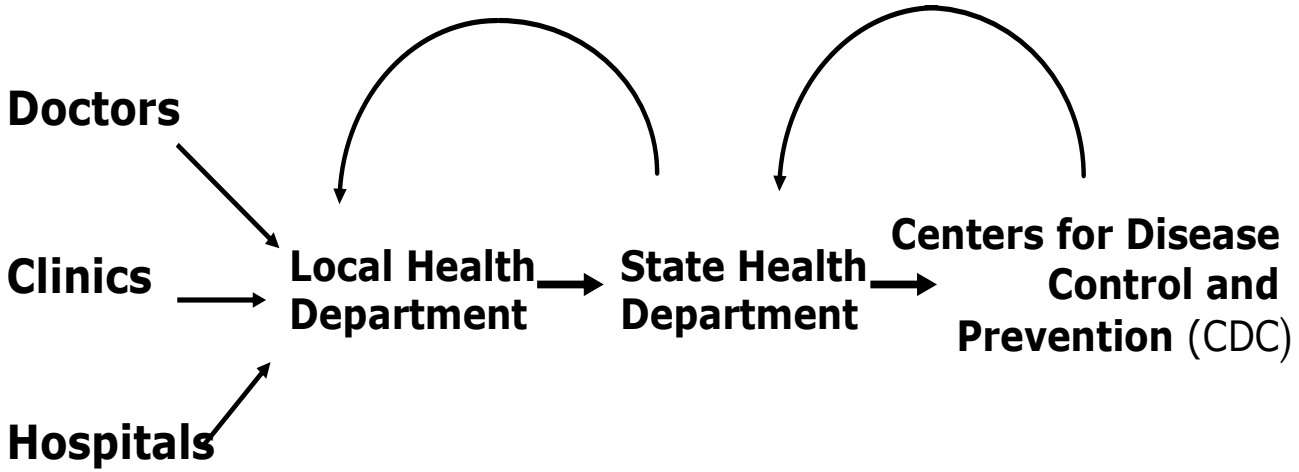
Importance of Rates

- Crude rates: entire population = denominator.
- Specific rates: measure morbidity or mortality for particular population or disease
- Age-adjusted rates: compare morbidity and mortality rates from populations with different age structures.

Reporting of Births, Deaths, Disease

- All births and deaths, and certain diseases, must be reported to health authorities.
- Local health depts.: summarize birth, death, disease records → report to state health depts. → report to CDC via National Electronic Telecommunication System.
- Local, state, fed. Govt. maintain vital and disease records → used by epidemiologists, health professionals to track disease.

Reporting Births, Deaths, & Diseases



Standardized Measurements of Health Status of Populations

- Death: most reliable indicator of health status of population.
- Non-communicable diseases: continue to be leading causes of death in U.S.; not so at beginning of 20th cent.
- Life expectancy = avg. # years a person from a cohort is expected to live: at birth, 65, 75 years.

Standardized Measurements of Health Status of Populations

- Years of Potential Life Lost (YPLL) = # of years death occurs before 65, 75. Weights death → young death counts more than old.
- Disability Adjusted Life Years (DALYs): measure of burden of disease, accounting for premature death, loss of healthy life from disability.
- Disability Adjusted Life Expectancy (DALE): # of healthy years expected for a population.

Sources of Standardized Data

- U.S. Census: useful info. for health workers.
- Statistical Abstract of U.S.: summary of useful social, political, economic statistics.
- Vital statistics: summaries of major life events: births, deaths, marriages, etc.
- ***Mortality and Morbidity Weekly Report***: cases of notifiable diseases in U.S.

Sources of Standardized Data

- National Health Surveys:
  - **National Health Interview Survey**: annual phone survey, by Nat. Center for Health Statistics.
  - **National Health and Nutrition Survey**: mobile lab, physical exam, lab testing, representative group.
  - **Behavior Risk Factor Surveillance System (BRFSS):** phone survey on high risk behavior, e.g. smoking, alcohol consumption.

Sources of Standardized Data

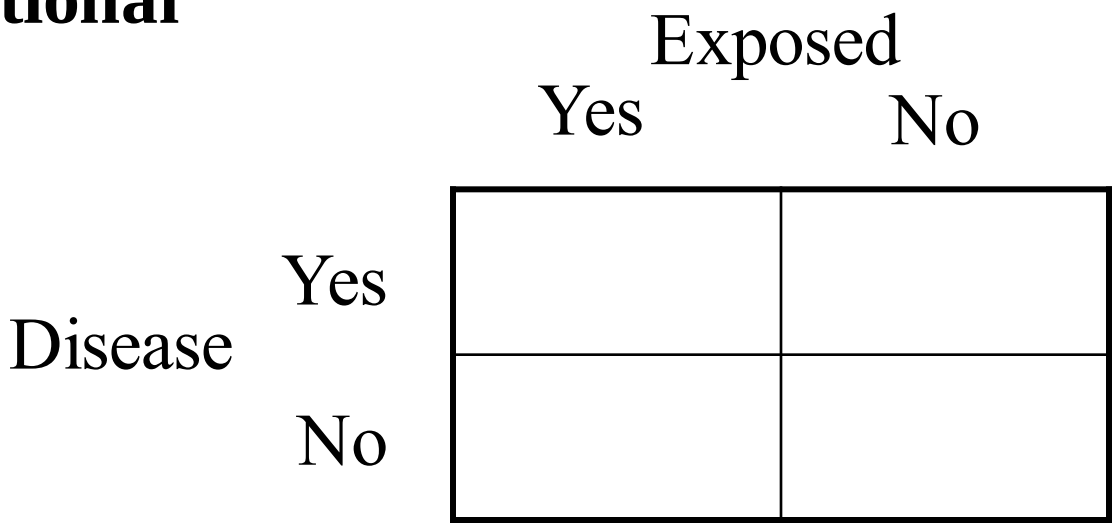
- National Health Surveys:
  - **Youth Risk Behavior Surveillance System**: surveys priority risks of youth. School, home, college based.
  - **National Hospital Discharge Survey**, National Hospital Ambulatory Medical Care Survey: data from recently discharge patients.

Epidemiological Studies

- **Descriptive studies**: describe extent of disease outbreak: person, place, time.
- **Analytical studies**: test hypotheses about relationships between health problems, possible risk factors.

Epidemiological Studies

- **Analytical Studies**
  - Purpose: testing of hypotheses about relationships between health problems and possible risk factors
  - Two basic types: **observational** and **experimental** studies
  - **Observational**



Epidemiological Studies

- **Analytical Studies (continued)–**
  - **Experimental (interventional)**
    - **Case/control study (retrospective):** compare people with disease to healthy people, similar age, sex, background, with respect to prior exposure to potential risk factors.
    - **Cohort study (prospective study):** subjects belonging to large group of similar experience (cohort), classified by exposure to certain risk factors, observed into future to determine disease outcomes.

Epidemiological Studies

- Other key terms:
  - Placebo: a blank dose treatment.

Causative Agents for Diseases and Injuries

Biological Agents	Chemical Agents	Physical Agents
Viruses	**Pesticides**	**Heat**
Rickettsiae	**Food additives**	**Light**
Bacteria	**Pharmacologics**	**Radiation**
Fungi	**Industrial chemicals**	**Noise**
Protozoa	**Air pollutants**	**Vibration**
Metazoa	**Cigarette smoke**	**Speeding object**

Classification of Diseases and Health Problems

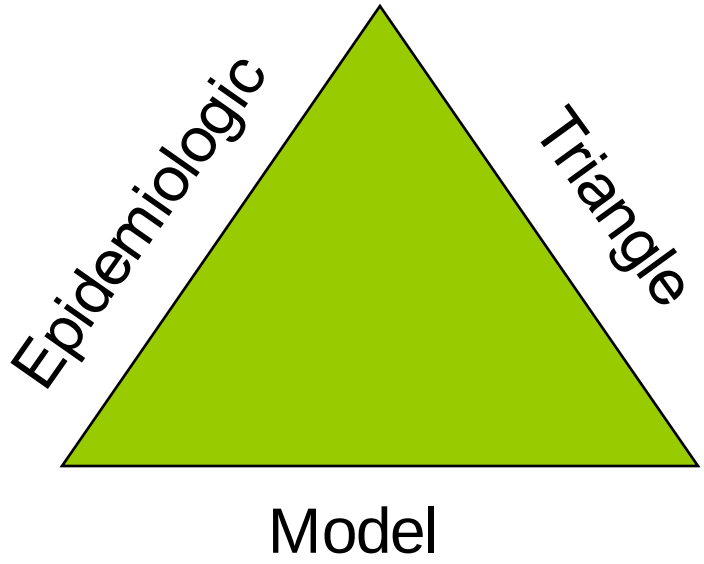
- Communicable vs. non-communicable diseases
  - **Communicable:** caused by pathogenic agents, transmitted from infected host to non-infected, susceptible host.
  - **Non-communicable:** cannot be transmitted from diseased host to susceptible one.

Classification of Diseases and Health Problems

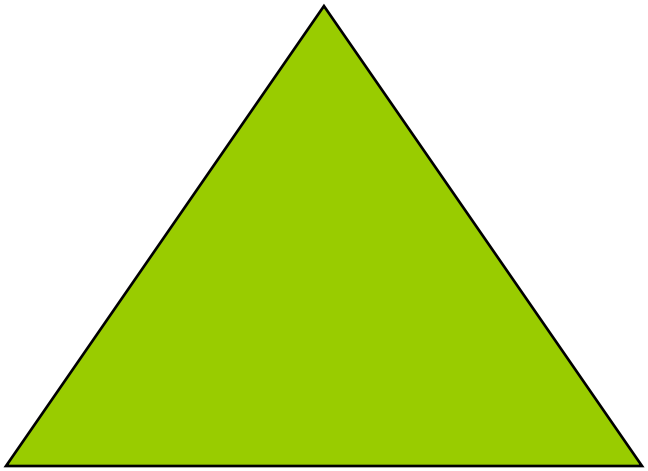
- Acute vs. chronic diseases, illnesses
  - **Acute**: peak severity occurs within 3 months of onset of illness.
  - **Chronic**: last longer than 3 months, sometimes rest of life.

Types of Diseases	Examples
Acute Diseases	
Communicable	Common cold, pneumonia, mumps, measles, pertussis, typhoid fever, cholera
Noncommunicable	Appendicitis, poisoning, trauma
Chronic Diseases	
Communicable	Tuberculosis, AIDS, Lyme disease, syphilis, rheumatic fever
Noncommunicable	Diabetes, coronary heart disease, osteoarthritis, cirrhosis of the liver

Communicable Disease Model



Communicable Disease Model

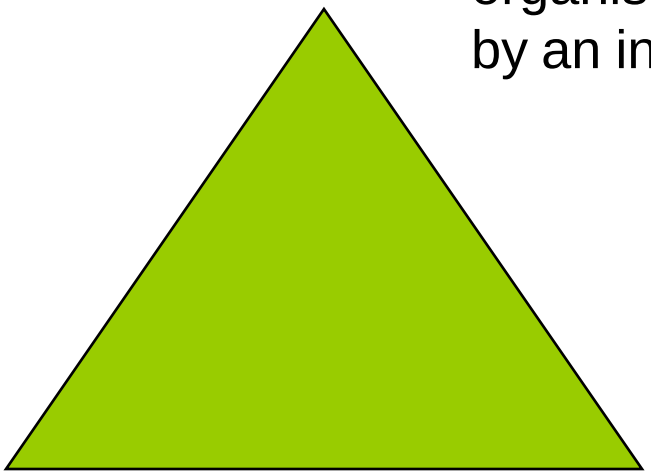


Agent The element that must be present in order for the diseases to occur

Communicable Disease Model

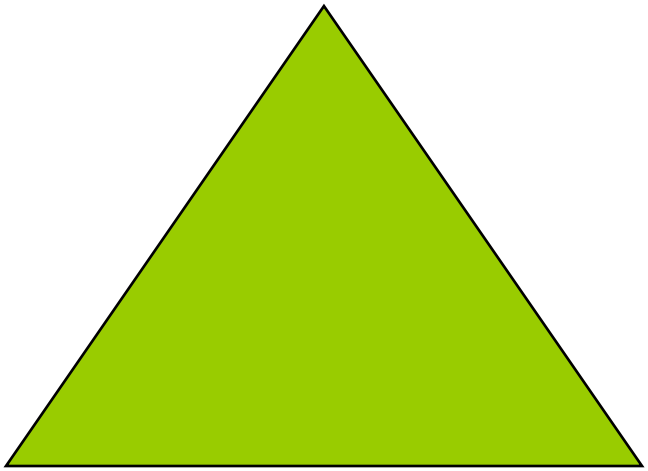
Host

Any susceptible organism invaded by an infectious agent



Agent

Communicable Disease Model



All other factors that inhibit or promote disease transmission

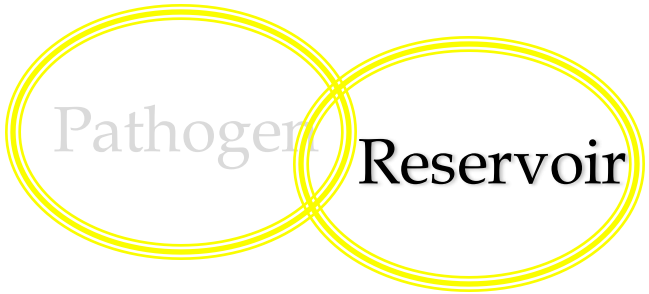
Chain of Infection

A model to conceptualize the transmission of a communicable disease from its source to a susceptible host

Chain of Infection

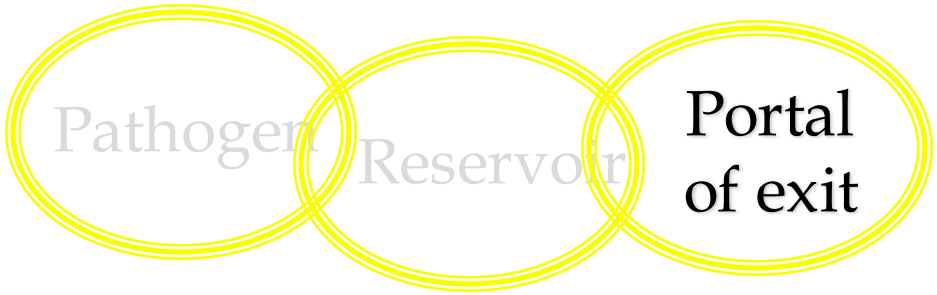
- The disease-causing agent

Chain of Infection



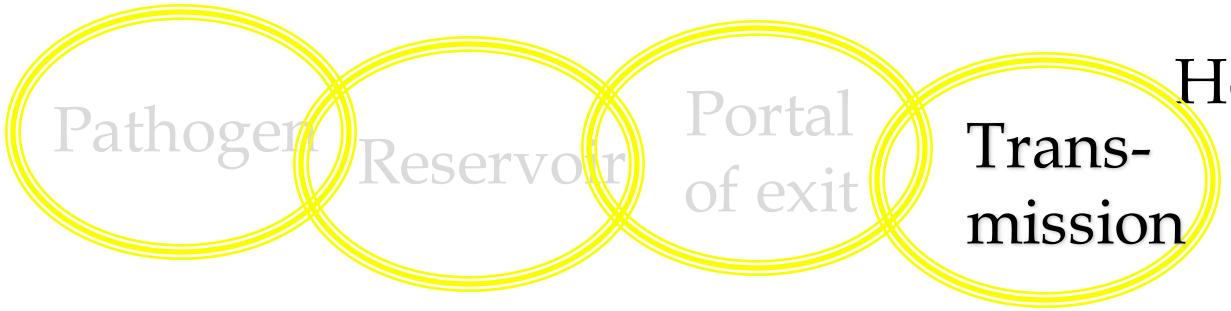
- **The habitat in which an infectious agent normally lives and grows**
  - **Human: Anthroponoses, symptomatic or asymptomatic**
  - **Animal: Zoonoses**
  - **Environmental: Plants, soil, and water**

Chain of Infection



- **The path by which an agent leaves the source host**

Chain of Infection



How pathogens are passed

Modes of Transmission

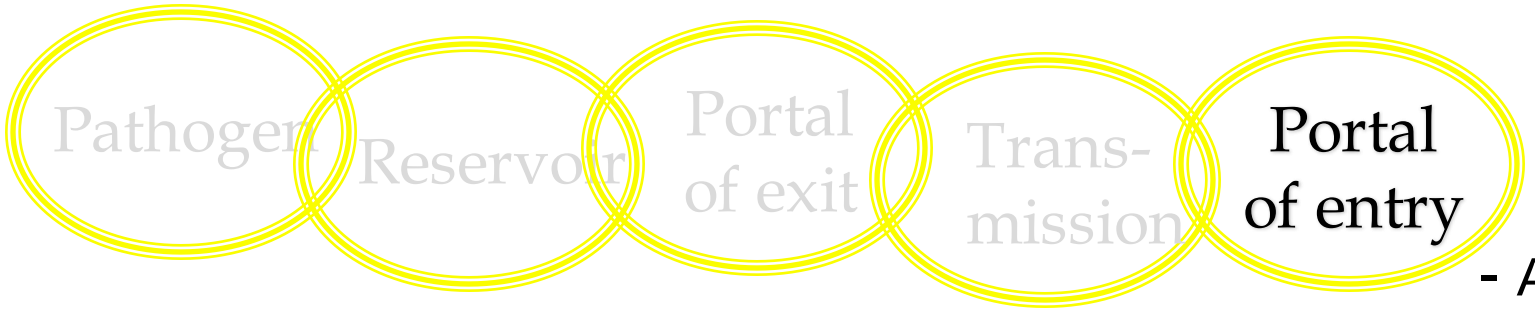
Direct: Immediate transfer

- **Direct contact**
- **Droplet spread**

Indirect

- **Airborne**
- **Vehicleborne**
- **Vectorborne**

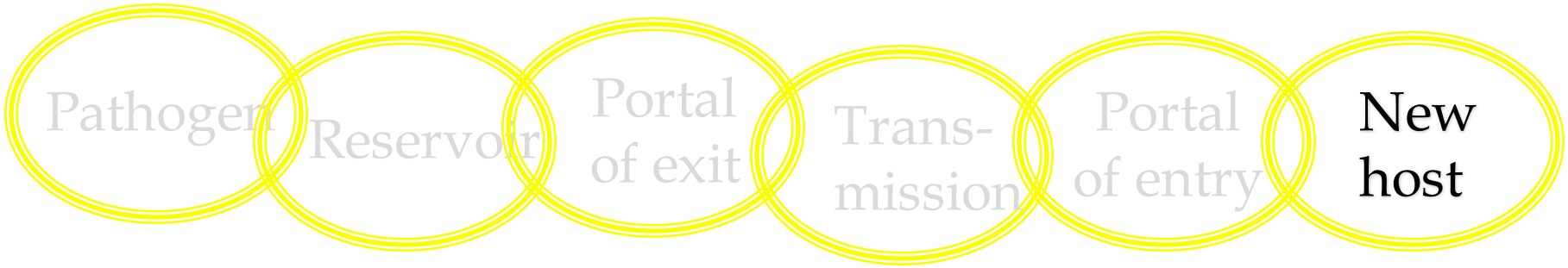
Chain of Infection



- Agent enters susceptible host

Respiratory
Oral
Skin
Intravenous
Gastrointestinal

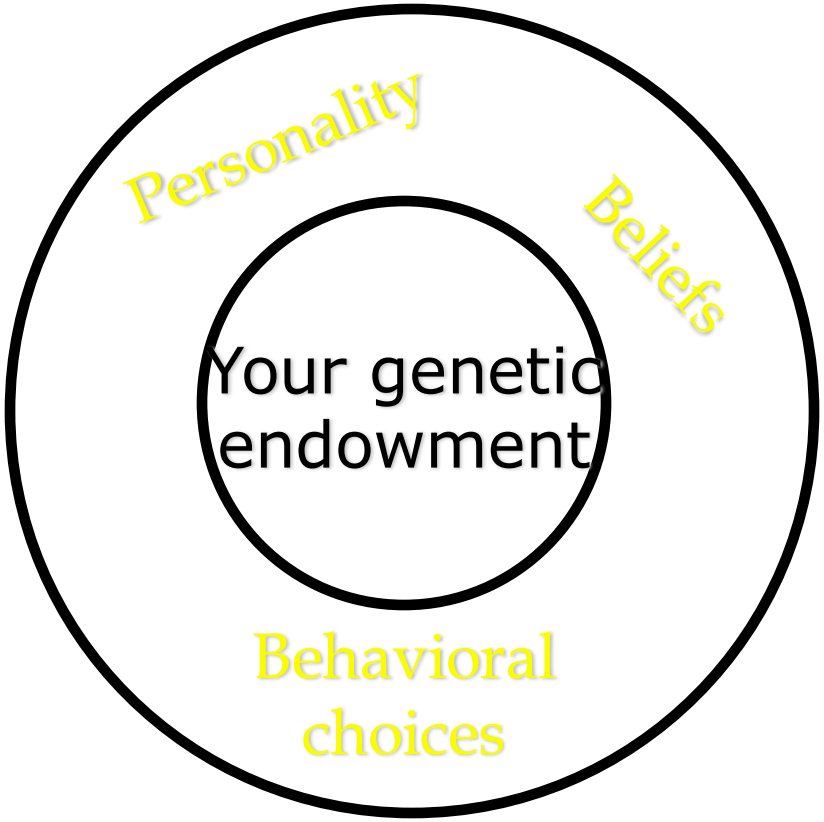
Chain of Infection



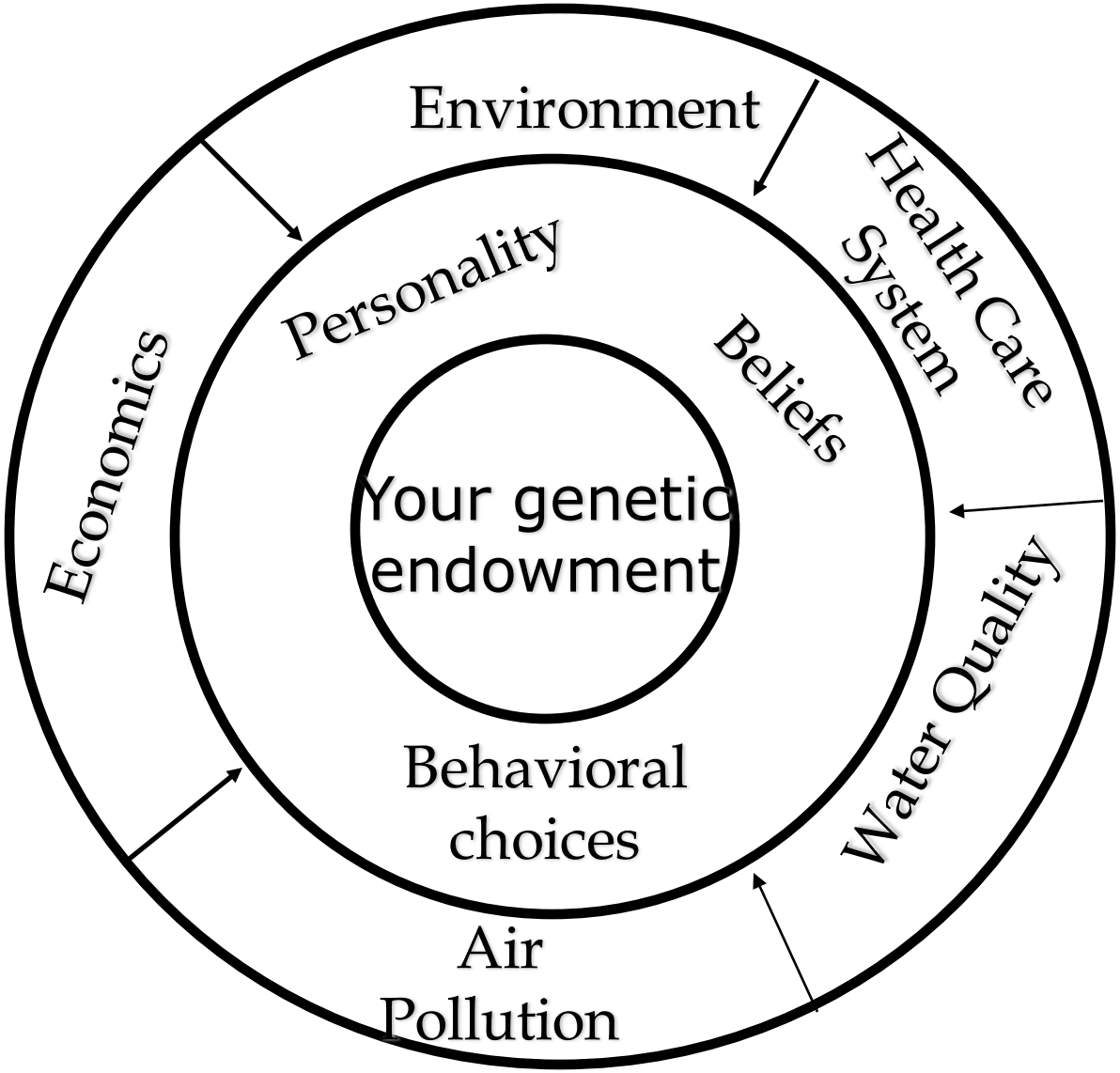
- Final link is a susceptible host

Noncommunicable Disease Model

Noncommunicable Disease Model



Noncommunicable Disease Model



Non-Communicable Diseases

- Multi-causation disease model
- Diseases of heart and blood vessels: leading cause of death in U.S.
  - Coronary heart disease -- #1 killer
  - Cerebrovascular disease (stroke) -- # 3 killer
- Malignant neoplasms (cancer): kill over half million per year. -- #2 killer
- Other non-communicable diseases: chronic obstructive pulmonary disease (#4 killer); diabetes (#7 killer) ; chronic liver disease (#10 killer).

Prioritizing Prevention and Control Efforts

- Leading causes of death: way to prioritize prevention.
- U.S. spends 66% of health care budget on 4 leading causes of death.
- Years of Potential Life Lost: impact of disease hitting at early age.
- Economic cost to society: another way to prioritize. Hard to get data.

Prevention, Intervention, Control, Eradication of Diseases

- **Prevention:** taking action to prevent or forestall onset of illness. (e.g. immunization)
- **Intervention:** taking action to control disease in progress (e.g. taking an antibiotic)
- **Control:** containment of disease (includes prevention and intervention).
- **Eradication:** Uprooting, elimination from a population.

Levels of prevention

- **Primary:** forestalling onset of illness, injury (e.g. immunization)
- **Secondary:** Early diagnosis, prompt treatment before disease is advanced. (e.g. screenings)
- **Tertiary:** Retraining, rehabilitating patient who has incurred disability. (e.g. physical therapy)

Prevention of Communicable Diseases

- Primary, Secondary, Tertiary
- Application of preventive measures: AIDS
  - Chain of infection: prevention, control at each link.
  - Universal precautions: barriers, handwashing, disposal of sharps.

Prevention of Non-Communicable Diseases

- **Primary prevention** (e.g. education)
- **Secondary prevention** (e.g. screening)
- **Tertiary prevention** (e.g. emergency medical services)
- Application of preventive measures: chronic heart disease
  - Community's role: recognizing role of prevention.
  - Individual's role: identifying, changing modifiable risk factors.