Introduction to Epidemiology

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Epidemiology

Basic science of public health

- Quantitative basic science built on a knowledge of probability, statistics, and sound research methods.
- Method of causal reasoning based on developing and testing biologically plausible hypothesis about health states and events.
- Provides a foundation for
  - directing public health actions,
  - causal reasoning,
  - understanding of what is practical and capable of being accomplished.

Epidemiology

- Origin of the term
  - Epi --- meaning „on“ or „upon“
  - Demos --- meaning „people“
  - Logos --- meanig the „study of“
- Emergency of the term
  - „Epidemiologia Espanola“, Madrid, 1802.
  - „London Epidemiological Society“, 1850s
- Meaning of the term
  - Study what befalls the population.

Epidemiology

Fundamental assumptions:

- Human disease does not occur at random
- Human disease has causal and preventive factors that can be identified through systematic investigation (comparison) of different populations or subgroups of individuals within a populations.

Epidemiology

Epidemiology is the 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.

(Last, 1995)

Epidemiology

- Study
  - Includes surveillance, observation, hypothesis testing, analytic research, and experiments.
    - Sound methods of scientific inquiry relying on careful observation and the use of valid comparison groups to determine whether the observed health events differ from what might be expected.

Epidemiology

- Distribution
  - Refers to analysis by time, place, and classes of persons affected.
  - Study of the frequency and pattern of health-related events.
    - Frequency – not only numbers of cases in a population, but the relationship of that numbers to the size of the population and the length of observation. The resulting rates are used to compare disease occurrence between different populations.
    - Pattern - description of health-related events by time, place and person.
  - **Descriptive epidemiology**
    - Answers the questions What, Who, When, and Where of health event.

Epidemiology

- Determinants
  - Causes or all physical, biological, social, cultural, and behavioral factors that influence health.
  - **Analytic epidemiology**
    - The process of assessing whether groups with different rates of disease have difference in demographic characteristics, genetic or immunologic makeup, behaviors, environmental exposures, and other so-called potential risk factors.

Epidemiology

- Health-related states and events
  - Include diseases, causes of death, behavior such as use of tobacco, reactions to preventive regimens , and provision and use of health services.
    - Emerged in relation with epidemics of communicable diseases, expanded to endemic infectious disease, in the middle of the 20th century focused on chronic noninfectious diseases, recently began to look „upstream“ to well-being.

Epidemiology

- Specified populations
  - Those with identifiable characteristics such as precisely defined numbers.
  - Population approach makes difference between epidemiology and clinical medicine
    - Distinct concerns
    - Distinct responsibilities
    - Distinct methods

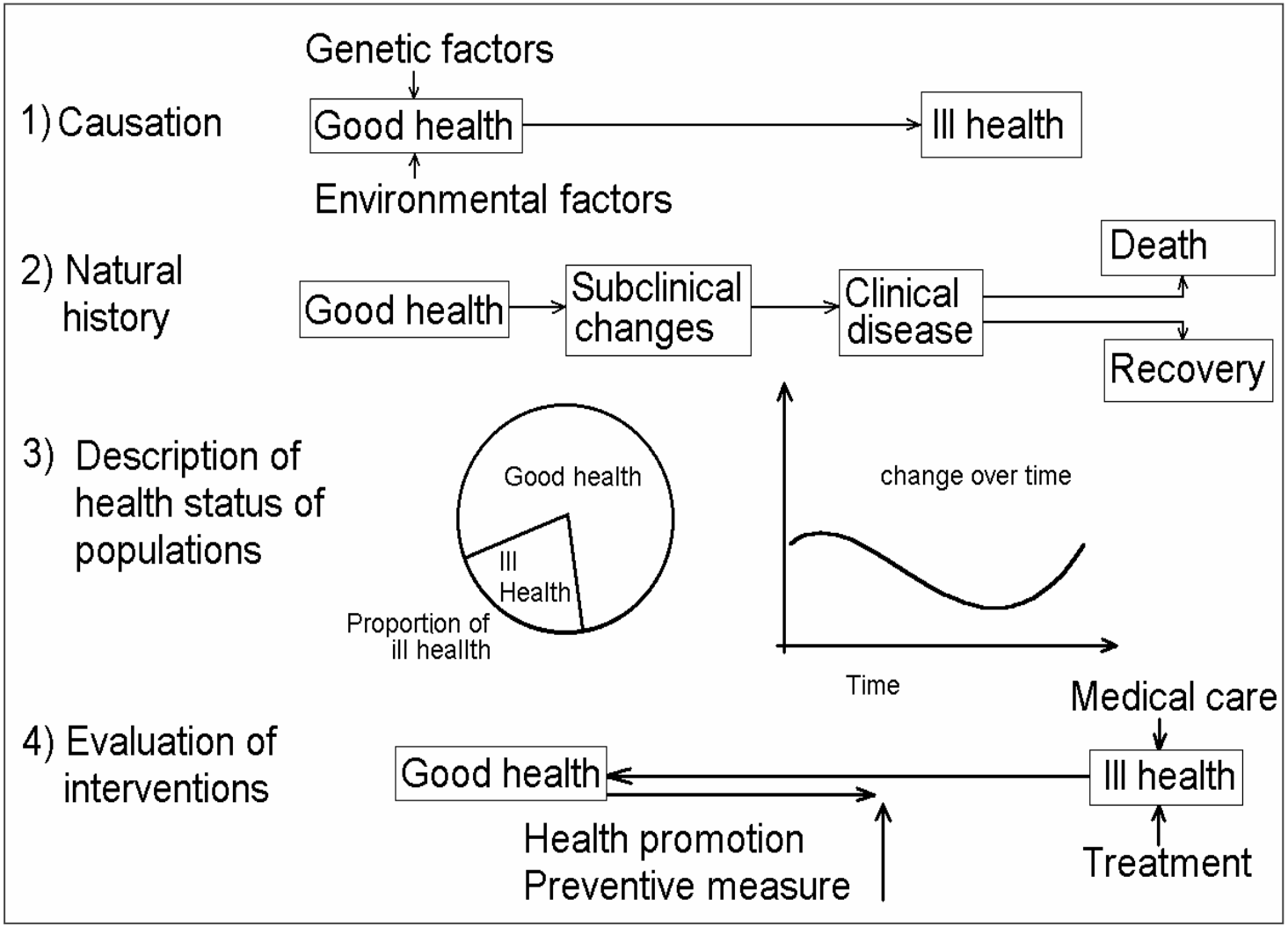
Epidemiology

- **Epidemiology**
  - *Establishing correct diagnosis*
  - Collective health of the people in community or population.
  - Source or exposure that caused the disease.
  - Number of person at risk of disease (similarly exposed).
  - Potential for spread of disease in community
  - Intervention to prevent additional cases or reoccurrence.
- **Clinical medicine**
  - *Establishing correct diagnosis*
  - Treating and caring for individual

Epidemiology

- „Application to control…“
  - Makes explicit the aim of epidemiology – to promote, protect, and restore health.
  - Involves science and art (as clinical medicine)
    - Clinician
      - To treat patients, he/she applies scientific knowledge, experience, and clinical judgment.
    - Epidemiologist
      - Will use the scientific methods of descriptive and analytic epidemiology as well as experience and epidemiologic judgment in diagnosis the health of the community.
      - Understanding is the clue to effective and efficient action.

Uses of epidemiology



Uses of epidemiology

Domains

- Population or community health assessment
- Individual decision
- Completing clinical picture of disease
- Search for causing

Uses of epidemiology

- Population or community health assessment
  - Epidemiologic information is factual framework for decision making in public health.
    - Descriptive epidemiology addresses the questions such as:
      - What are actual and potential problems?
      - Where are they occurring?
      - Who is at risk?
      - Which problems are declining/increasing over time?
      - How disease pattern relate to the level and distribution of available services?
      - What is the progress of intervention?

Uses of epidemiology

- Individual decision
  - Smoking → quit smoking
  - Waiting for elevator → Climbing stairs
  - Cheeseburger with fries → vegetable salad
  - Promiscuity → Safe sexual behavior

  - *Epidemiologic findings are directly relevant to the choices that people make every day, choices that affect their health over a lifetime.*

Uses of epidemiology

- Completing clinical picture of disease
  - Analysis of individual cases vs. cohort analysis
    - Eosinophilia-myalgia syndrome
    - HIV
    - Smoking

Uses of epidemiology

- Search for causes
  - Public health perspective
    - Identification of risk factors suitable for intervention
      - Cause as a link in the causal chain from exposure to health event
        - J. Snow, cholera in the Golden Square area in 1854, the removal of handle from the Broad Street pump.
        - Legionnaires's disease, American Legion Convention in Philadelphia in 1976, hotel lobby as risk factor; however, outbreak not solved until Legionella pneumophila was identified 6 month later.
  - Academic perspective
    - Full understanding of the causation (concept of component cause in epidemiologic research)

Core epidemiologic functions

- Minimum recommended capacity of a state health department's epidemiology unit:
  - Public health surveillance
  - Investigation and consultation
  - Policy development
  - Training
  - Linkages

Core epidemiologic functions

- Public health surveillance
  - Ongoing systematic collection, analysis, interpretation and dissemination of health data to help guide public health decision making and action.
    - The purpose is to portray the ongoing pattern of disease occurrence and disease potential so that investigation, control, and prevention can be applied efficiently and effectively.
    - Accomplished through the systematic collection and evaluation of morbidity and mortality reports and other relevant health information, and the dissemination of these data and their interpretation to those involved in disease control and public health decision making.

Core epidemiologic functions

- Field investigation and analytical studies
  - Vary in scope and objectives
    - Identification of additional unreported and unrecognized cases (sorces of infection)
    - Identification of vehicle
    - The natural history, clinical spectrum of disease
    - Cluster, outbreaks investigation
  - Descriptive and analytic epidemiology
    - Design, conduct, analysis, interpretation, communication

Core epidemiologic functions

- Policy development
  - Epidemiologists who understand the problem and the population in which it occurs are often in a uniquely qualified position to recommend appropriate interventions.

Core epidemiologic functions

- Linkages
  - Epidemiology is sometimes referred to as a „team sport“
    - During field investigation epidemiologist usual participates as either member of or leader of a multidisciplinary team.
  - Maintaining linkages with agencies and institutions, whether through official linkages or through publication of periodic bulletins for public health audiences and outside partners.

The basic operation of epidemiologist

- Focus of epidemiologic investigation:
  - A population of people, large or small, who share some health event (illness).
- The task of investigation:
  - To find out why became ill, what is the agent, how it was transmitted, who is at risk, what is critical exposure…

The basic operation of epidemiologist

At least five separate operation are performed in virtually all epidemiologic studies.

1. Counting cases.
2. Description of the cases in terms of time, place, and person.
3. Extracting from that description a plausible hypothesis that will explain all the facts of the epidemiologic event.
4. Determination of rates of illness or rates of exposure.
5. Comparison of these rates to see what they mean.

An Introduction to Communicable Disease Epidemiology

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Impact of infectious diseases

- Major killers before the 1800s
  - Smallpox
  - Measles
  - Plague

Impact of infectious diseases

- Epidemics have been supposed to influence
  - The Fall of the Roman Empire
  - Dramatic social and economic changes in Europe
  - Fall of Inca and Maya civilizations

Malaria

- Approximately 350–500 million cases of malaria, killing between one and three million people, the majority of whom are young children
- Evolutionary pressure of malaria on human genes
  - Sickle-cell disease (mutation in the *HBB* gene, which encodes the beta-globin subunit of haemoglobin)
  - Gene frequency of β-thalassaemias
    - Related to the level of malarial endemicity
  - Glucose-6-phosphate dehydrogenase (G6PD) deficiency
    - Protects from the effects of oxidative stress in red blood cells.
    - Increased protection against severe malaria

Leprosy

- Mycobacterium leprae
  - Bacterium in the same family of bacteria that causes TB
  - Provoke similar immune responses.
  - Less than 10% exposed ever develop leprosy, and only ½ of these individuals ever develop the disfigurement associated with leprosy.
  - Affacted mankind at least since 600 BC

Leprosy

- 13th century
  - Unprecedented outbreak
  - 19 000 leprosaria in Europe
  - The oldest infirmaries in France, Italy and England began as leper houses.

The invention of the hospital as a place to segregate and house the sick grew from leper houses.

Plague

- Bubonic form of plague
  - From infected fleas
  - Kills more than half its victims within a week
- Pneumonic form of plague
  - Spread by cough and spit of the infected.
  - Victims died within 24 hours.
- Septic form

Plague

- **Plague of Justinian** 541
  - First recorded outbreak of the bubonic plague
  - Constantinople 10 000 death per day and perhaps 40% of the city's inhabitants
- **Black death started** 1300s
  - The total number worldwide 75 000 000 deaths
  - 1348 – 1354 killed 20–30 mil. Europeans (1/3 of the total population)
  - Over a period of 100 years the plague killed 10 – 15% of each new generation.
- **Third pandemic** - middle of the 19th century
  - Spread from China, killing 10 mil. in India alone.
- It took Europe 300 years top regain its population.

Smallpox

- Emerged in human population about 10,000 BC.
- Antonine plague 165 – 180
  - Possibly smallpox brought to the Italian penisula by soldiers returning from the Near East
  - Killed ¼ of infected, and up to 5 mil in all.
- Killed an estimated 400 000 Europeans each year during the 18th century,
- Responsible for a third of all blindness
- Death rate 20 – 60 % (80% in small children)

- Edward Jenner (1796) - vaccination
  - Inoculation a person with material from a cowpox lesion

Smallpox

- 16th century
  - Killed the entire native population of Canary Islands in 16th century
  - The „Great Fire“ („Easy Death“) killed 2/3s of the Mayan population.
- 17th century
  - 1618-1619 wiped out 90% of the Massachusetts Bay Native Americans
- 18th
  - 1837-1838 drastic depopulation of Plains Indians

Death of 95% of the Native American population of the New World was caused by Old World diseases such as smallpox, measles, and influenza.

Syphilis

- Carried back from the New World to Europe by Columbus and his men.
  - Hypothesis: Europeans could have carried the nonveneral tropical bacteria home, where the organisms may have mutated into a more deadly form in the different condition of Europe.
  - Disease had higher fatal rates than it si today.

Syphilis

- The major killer in Europe during the Renaissance.
- Between 1602-and 1796 Dutch East India Company sent almost a 1 mil. Europeans in the Asia; 2/3 not returned, died because of disease.
- Killed more British soldiers in India than war. Between 1736-1834 only some 10% of the East India Company's survived.

Syphilis

- In the 16th century, fear of spread lead to disappearance of public bathhouses.
- Treatment with mercury resulted in death by mercury poisoning.
- Public greeting by kissing was replaced with handshakes.

Cholera

- 7 Pandemics:
  - 1816-1826
  - 1829-1851
  - 1852-1860
  - 1863-1875
  - 1881-1896
  - 1899-1923
  - **1962-1966**
    - El Tor strain of V. cholerae,
    - Bangladesh, India, USSR

Tuberculosis (TB)

- During 19th century, more than 70% of all Europeans were infected with TB. (70-90% of urban populations)
- Killed ¼ of adult population in Europe
- 20th century 100 mil. people

- 1/7 of infected died from the disease.

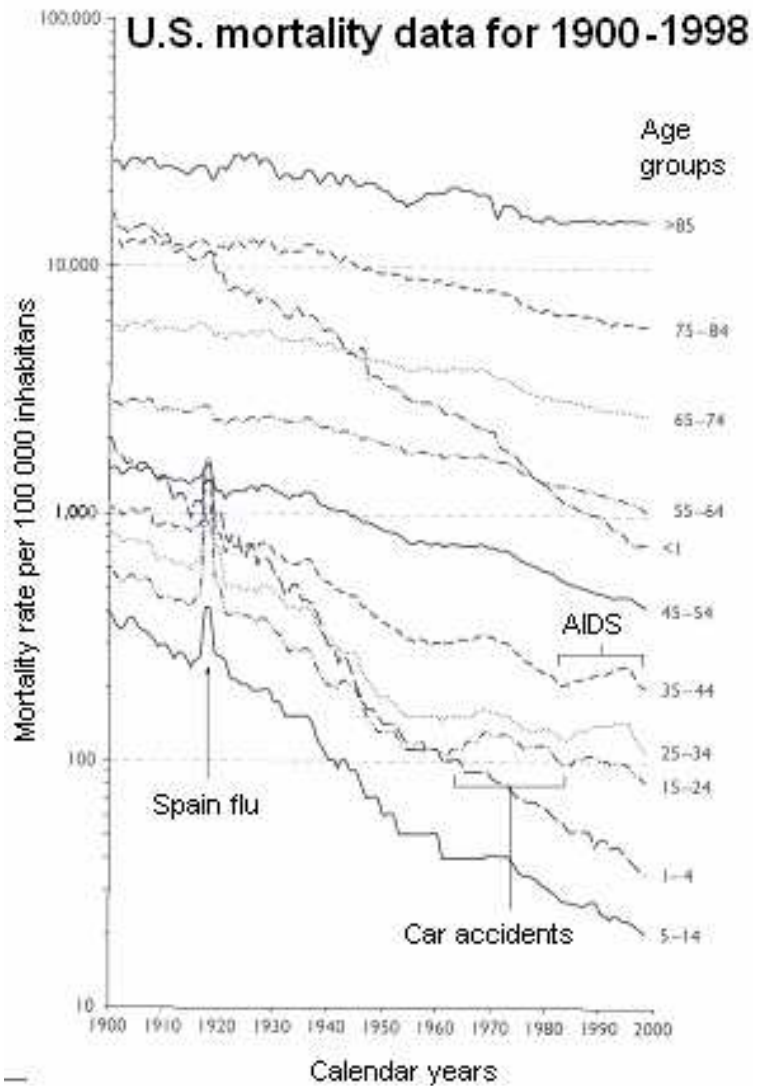
Influenza (Flu)

- First described by Hippocrates in 412 BC
- First pandemic in 1580
- Occurrence of pandemics in 10-30 years intervals
- Asiatic flu 1889—1890
  - H2N8 virus, very high attack and mortality rate, killed 1 mil. of people

Influenza (Flu)

- Spanish flu
  - The biggest die-off in world history: 1918-1919 50 million died in 13 months.
- Asian flu 1957-1958 (H2N2)
- Hong Kong flu 1968-69
  - H3N2 viruses still circulate today
  - Flu virus mutates and changes every 10 – 14 years, making it almost invincible.

Influenza (Flu)



Influenza (Flu)

HIV (AIDS)

- Caused by a retrovirus known to cripple the immune system.
- 1981 – first reported case in the U.S.
- Virus discovered by Drs. Barre-Sinoussi and Montagnier in 1983.
- „Patient Zero“ – Gaetan Dugas – Canadian airline steward.
- Major public health challenge.

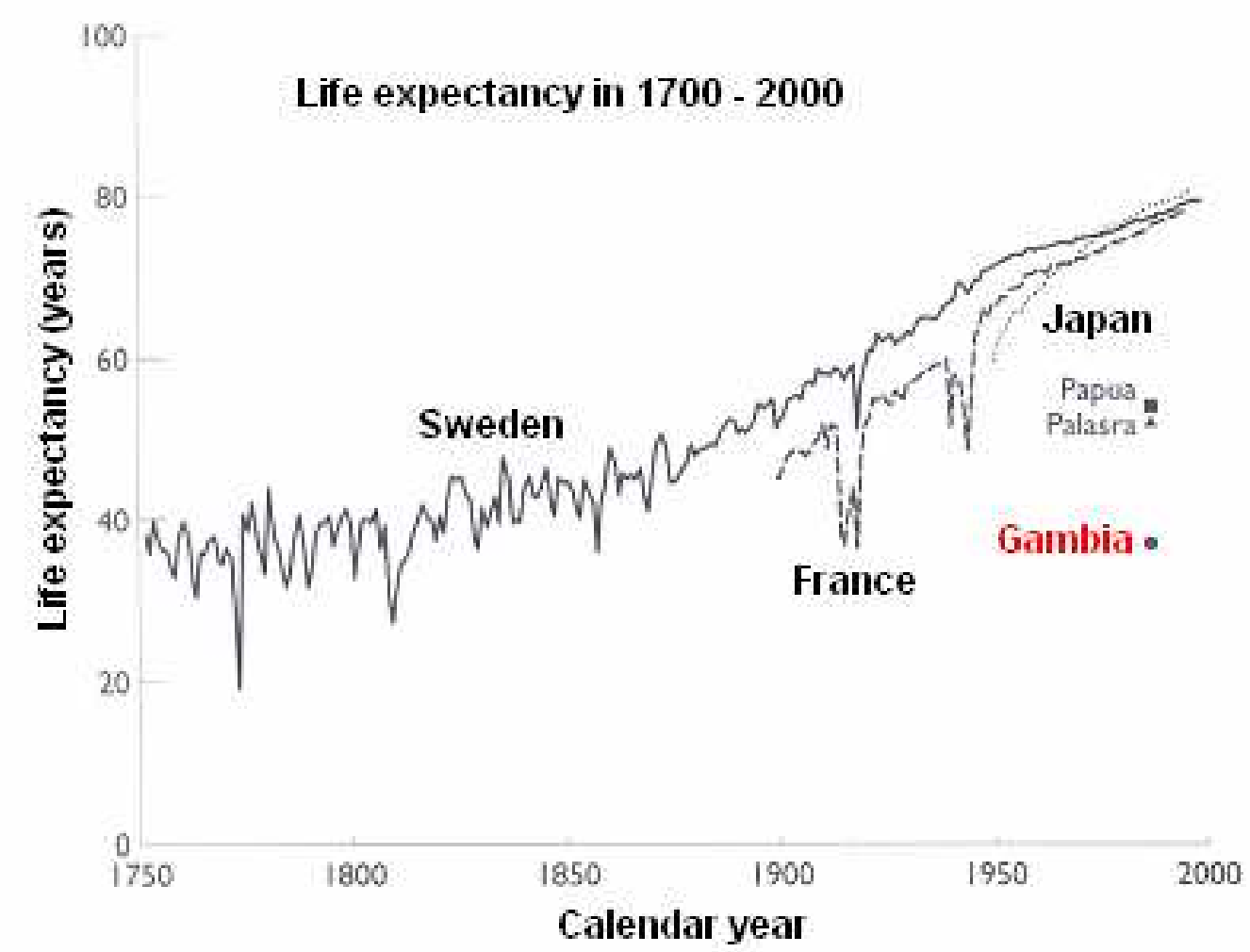
Infectious diseases and pattern of mortality

Top 10 Causes of Death in the USA							
1900				2000			
Rank	Cause of death	Death per 100,000	Percent of all Death	Rank	Cause of death	Death per 100,000	Percent of all Death
1	Pneumonia	202	12	1	Heart disease	258	30
2	Tuberculosis	194	1	2	Cancer	200	23
3	Diarrhea and enteritis	140	8	3	Stroke	60	7
4	Heart disease	137	8	4	Lung disease	45	5
5	Chronic nephritis	81	5	5	Unintentional injury	34	4
6	Unintentional injury	76	4	6	Diabetes	25	3
7	Stroke	73	4	7	Pneumonia and influenza	24	3
8	Disease of early infancy	72	4	8	Alzheimer's disease	18	2
9	Cancer	64	4	9	Nephritis, Kidney disease	14	2
10	Diphtheria	40	2	10	Septicemia	12	1

Infectious diseases and population survivorship

Age	17th century, London, England	2002, USA
0	100	100
6	64	91
16	40	99
20	25	91
36	16	97
46	10	95
56	6	91
66	3	81
76	1	63

Impact of infectious diseases



Achievements of communicable disease epidemiology

- Identification of water as a major reservoir and vehicle of communicable diseases such as cholera or typhoid fever (1849 – 1856)
- Identification of arthropod vectors for many diseases – malaria, yellow fever, sleeping sickness, typhus (1895 – 1909).
- Identification of the asymptomatic carrier as an important vector in typhoid, diphtheria, polio (1893 – 1905).

Achievements of communicable disease epidemiology

- Eradication of smallpox (1978)
- Perinatal hepatitis B infection necessary cause of hepatocelluar carcinoma (commonest cancer in China, Southern Africa) (1970-1980s).
- Identification of the HIV (AIDS), prediction that the cause is sexually transmitted virus (1981-3), and development preventive measures before the virus was identified.

Achievements of communicable disease epidemiology

- Toxic shock syndrome
- African haemorhagic fevers
- Rheumatic fever

- Many other…

Concept of disease occurrence

Concept of disease occurrence

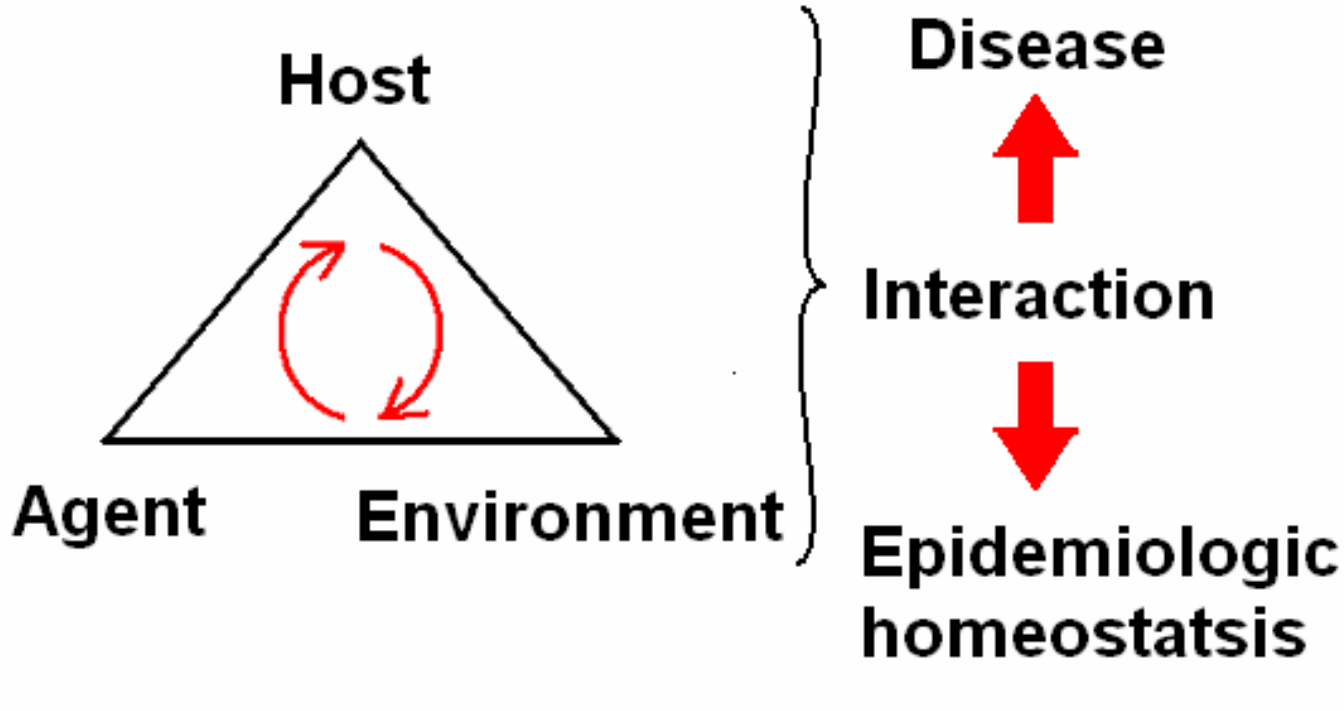
Epidemiologic dogma:

- Disease does not occur at random.
- Disease has causal factors that can be identified through systematic investigation of different populations or subgroups of individuals within a population in different places or at different times.

Concept of disease occurrence

Causation

- Epidemiologic triad / triangle



Concept of disease occurrence

Agent

- Necessary but may not be sufficient.
  - Biological
    - Microorganisms, helmints…
  - Chemical
    - Nutrients, allergens, carcinogens….
  - Physical
    - Radiation, vibrations, noise, trauma…
  - Psychological, socio-economic factors…

Inadequate model for many diseases having multiple contributing causes without a single necessary one.

- *Cancer, cardiovascular diseases…*

Concept of disease occurrence

Biological agents

- Prion
- Virus
- Ricketssia
- Bacterium
- Fungus
- Protozoan
- Helminth
- ……

Concept of disease occurrence

Biological agents

- Infectivity (attack rate)
  - Proportion of exposed persons who became infected
- Pathogenicity
  - Proportion of infected individuals who developed clinically apparent disease
- Virulence
  - Proportion of clinically apparent cases that are severe or fatal.
  - case fatality rate
- Immunogenicity
  - Infection's ability to produce specific immunity
- Properties of agent-host interactions!
  - All are dependent upon the condition of the host.

Concept of disease occurrence

Host factors

- **Determine**
  - **Likelihood of exposure**
  - **Chance of disease**
  - **Severity of disease**
- **Genetically determined and acquired factors**
  - **Age**
  - **Gender**
  - **Genetic predispositions**
  - **Immunologic status**
  - **Behavioral factors (smoking, drug abuse, lifestyle, sexual practices…)**
  - **Socio-economic status**

- **Environment**
  - Affects both agent and host.
  - Determines opportunity for exposure.
  - Physical factors
    - Geology, climate
  - Biologic factors
    - Insect vectors
  - Socio-economic factors
    - Crowding, sanitation, availability of health services.

The Natural History and Spectrum of Disease

The natural history and spectrum of disease

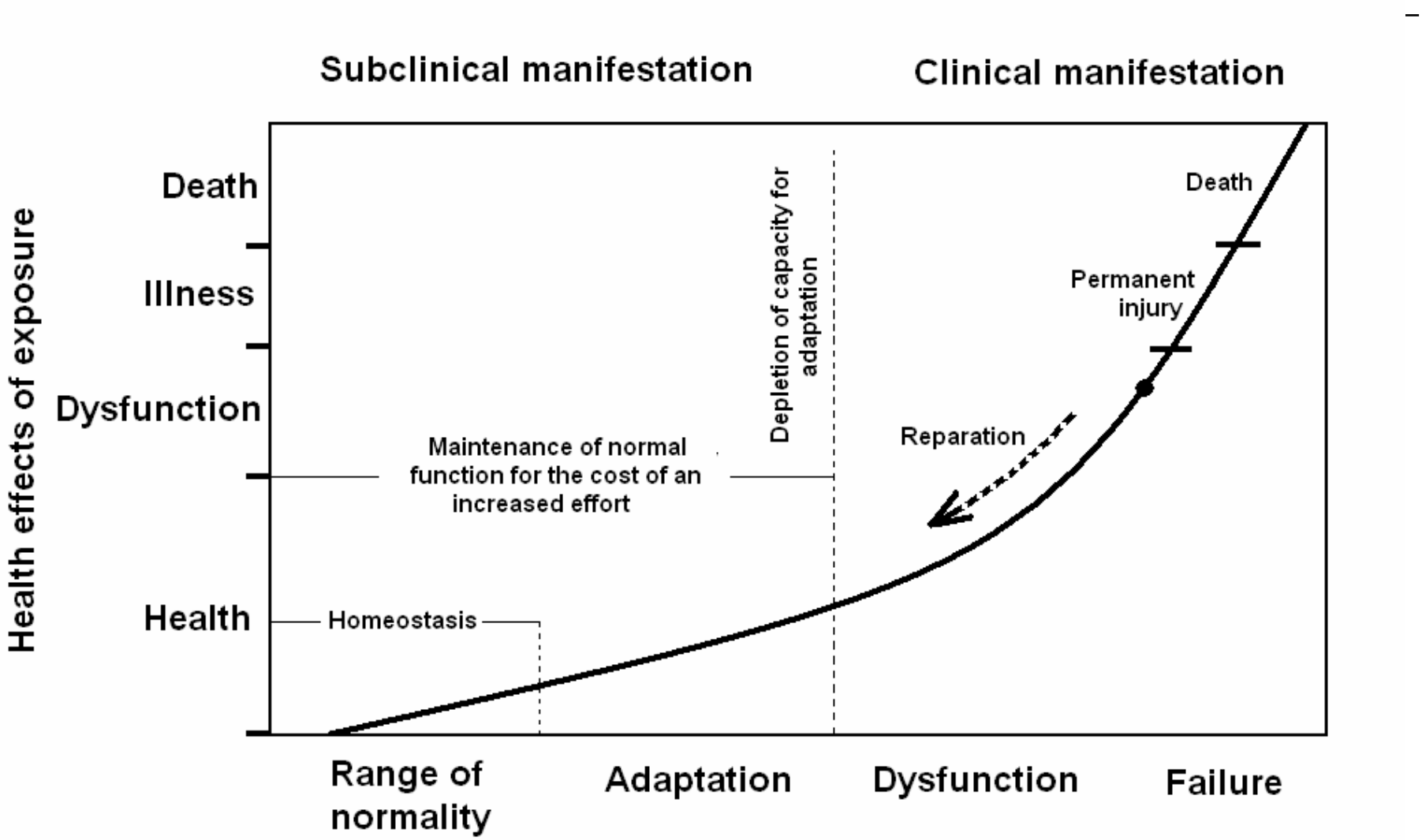
Progression of a disease process in an individual over time, in absence of intervention.

- Diseases have a characteristic natural history.
  - Time frame and specific manifestations of disease may vary from individual to individual
  - Is influenced by preventive and therapeutic measures.

The natural history and spectrum of disease

- Exposure
- Incubation/latency period
  - Subclinical manifestation
- Symptoms
  - Pathological changes
  - Spectrum of clinical illnesses
- End
  - Recovery, disability, death

The natural history and spectrum of disease



The natural history and spectrum of disease

- **Exposure / completion of sufficient cause**
  - Sufficient exposure of susceptible host
    - Properties of agent, dose, exposure pathway, host factors
  - Accumulation of necessary factors in susceptible host.
    - Cancer iniciation, cancer promotion

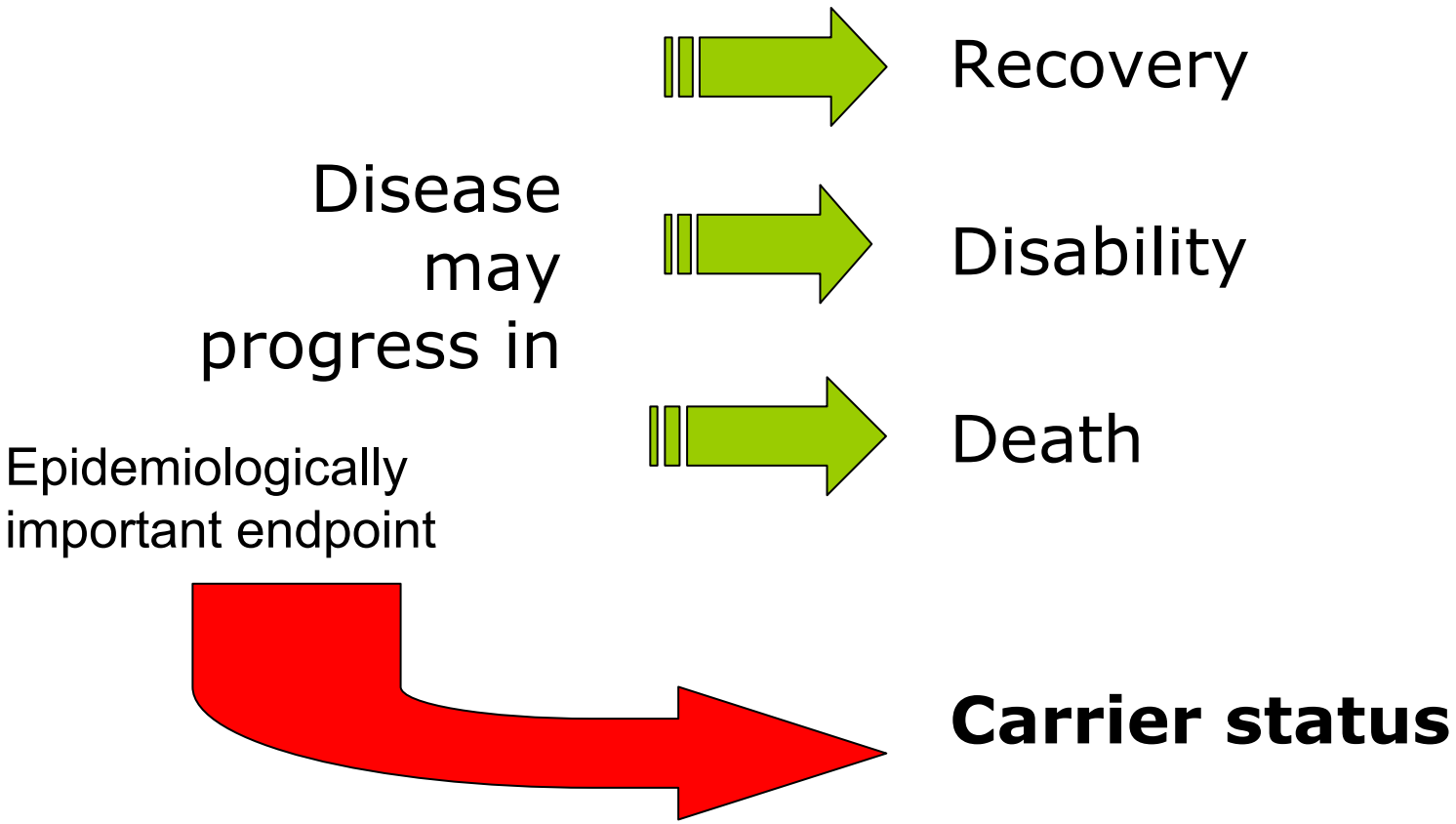
The natural history and spectrum of disease

- **Incubation period/latency period**
  - Period extending from the time of exposure to the onset of disease symptoms
    - The time required for the multiplication of microorganisms within the host up to a threshold where parasitic population is large enough to produce symptoms
    - Each infectious disease has a characteristic incubation period dependent upon
      - Rate of growth of the organisms in the host
      - Dosage
      - Portal of entry
      - Immune response of the host
      - Because of interplay of these factors, incubation period will vary among individuals

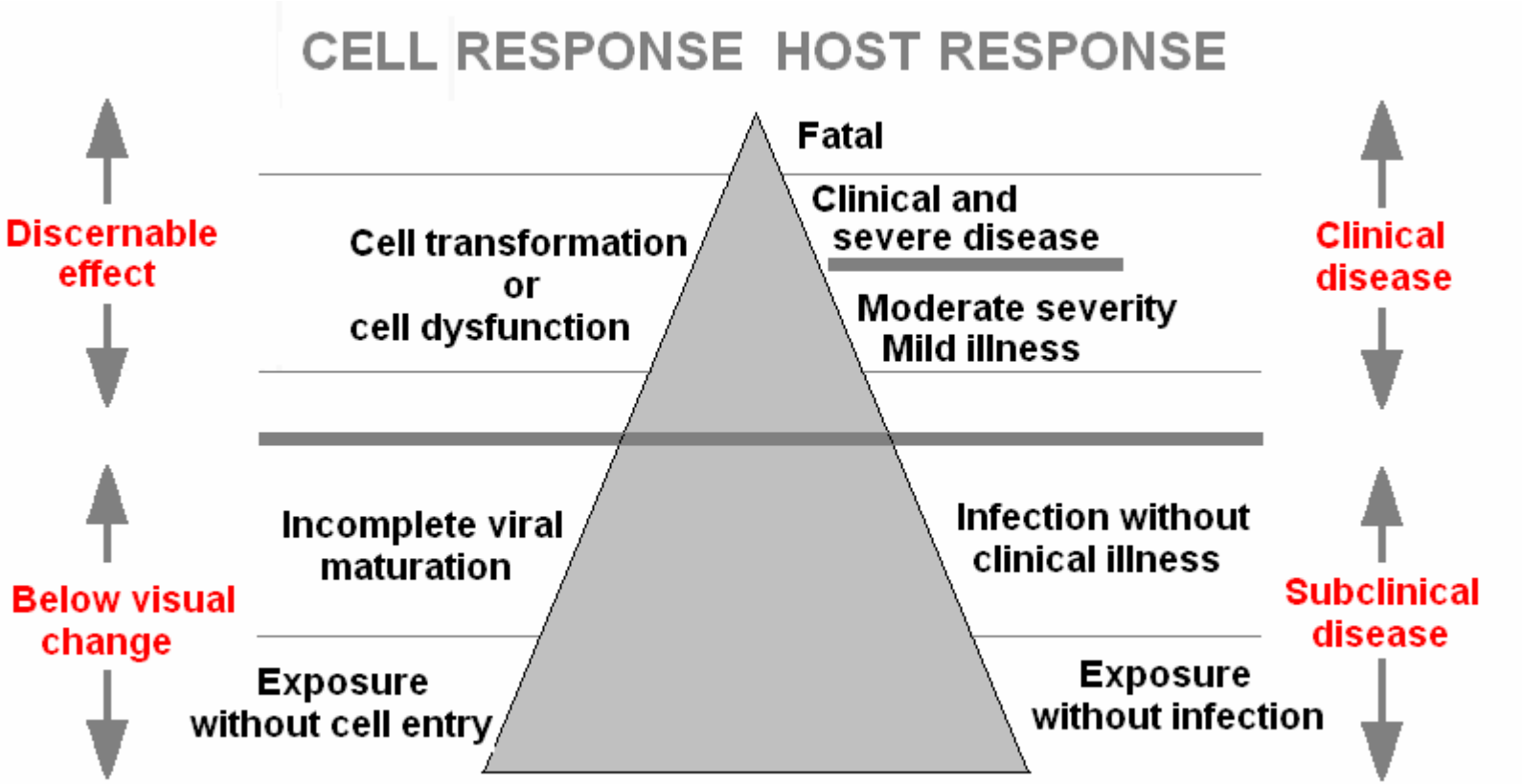
The natural history and spectrum of disease

- Clinical disease
  - Specific manifestation
    - Mumps
      - Children: Fever and swelling of parotid glands…
      - Adult men: Orchitis
  - Nonspecific manifestation
    - Hepatitis
      - Fatigue, mild gastrointestinal upset … icterus… cirrhosis. liver failure
  - Wide spectrum of clinical illness
    - Tuberculosis

The natural history and spectrum of disease



Iceberg concept of infection



Iceberg concept of infection

- Examples
  - 90% of measles cases exhibit clinical symptoms
  - 66% of mumps cases exhibit clinical symptoms
  - <10% of poliomyelitis cases exhibit clinical disease

Inapparent infections play a role in transmission. These are distinguished from latent infections, where the agent is not shed.

Iceberg concept of infection

Subclinical/Clinical ratio for viral infections

Virus	Clinical feature	Age at infection	Estimated ratio	Clinical cases
Polio	Paralysis	Child	± 1 000 : 1	0,1% to 1,0%
Epstein-Barr	Mononucleosis	1-5 years	>100 :1	1%
		6-15 years	10 : 1 – 100 : 1	1% to 10%
		16-25 years	2 : 1 – 3 : 1	50% to 75%
Hepatitis A	Icterus	< 5 years	20 : 1	5%
		5-9 years	11 : 1	10%
		10-15 years	7 : 1	14%
		Adult	1,5 : 1	80% to 95%
Rubella	Rash	5-20 years	2 : 1	50%
Influenza	Fever, cough	Young adult	1,5: 1	60%
Measles	Rash, fever	5-20 years	1: 99	> 99%
Rabies	CNS sympt.	Any age	< 1 : 10 000	>>>>99%

The natural history and spectrum of disease

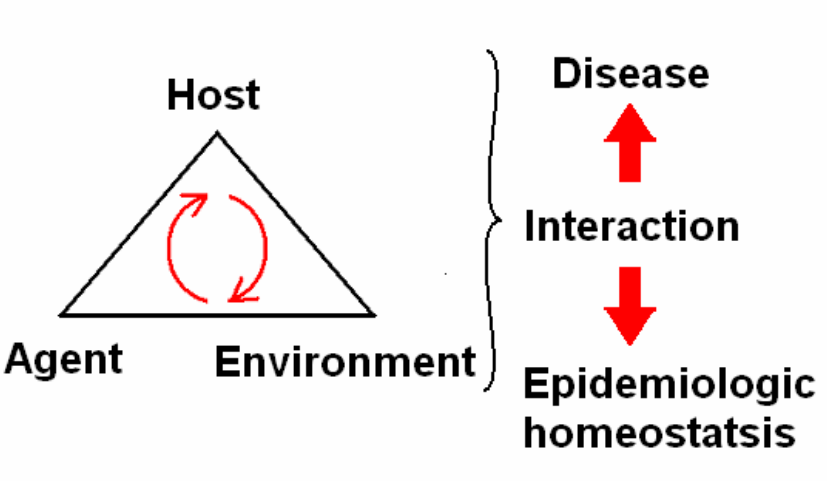
Carrier state

- A person or animal that harbors a specific infectious agent in the absence of discernable clinical disease and serves as a potential source of infection.
  - Healthy asymptomatic carriers (Staphylococcus, Streptococcus..)
  - Incubatory carriers (Hepatitis B, HIV)
  - Convalescent carriers (Salmonellosis)
  - Postconvalescent carrier (Hepatitis B)
- Transient carrier vs. chronic carrier
- Intermittent carrier (Typhoid fever, Herpes labialis)
  - Latent infections (Herpes labialis)

Chain of Infection

Chain of Infection

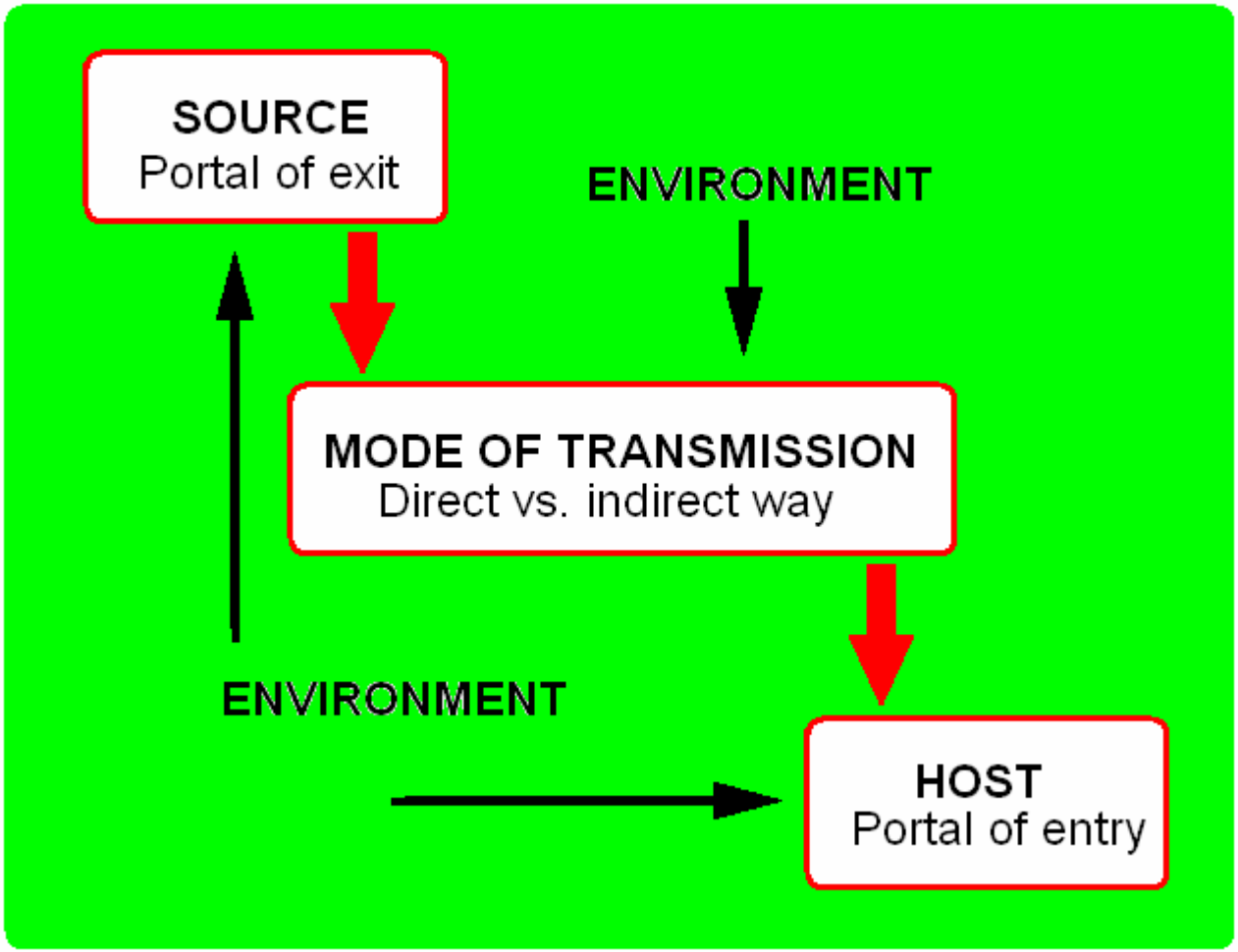
Epidemiologic triad



Chain o f infection:

Sequence of events preceding the development of infection.

Chain of Infection



Chain of infection

Source of infection

- The person, animal, object, or substance from which an infectious agent passes to a host.

Reservoir of infection

- Any person, animal, arthropod, plant, soil, or substance or combination of these in which an agent normally lives and multiplies, on which is dependent primarily for survival, and where it reproduces itself in such a manner that it can be transmitted to a susceptible host.
- The natural habitat of the infectious agent.

Chain of infection

- Source vs. reservoir
  - Reservoir may or may not be the source from which an agent is transported to a host.
    - The reservoir of Clostridium botulinum spores is soil,
    - The source of most botulism intoxication is improperly canned food containing C. botulinum spores and a neurotoxin released by the bacteria.

Chain of Infection

- Human reservoirs
  - Sexually transmitted diseases
  - Infectious hepatitis
  - Many respiratory infections
    - Measles, mumps…
    - Streptococcal infections
  - ***Eradication of smallpox***

Chain of Infection

- Animal reservoirs
  - **Zoonosis**
    - **Usually disease transmitted from animal to animal, with human as an incidental host.**
    - **Tularemia (hare)**
    - **Brucellosis (caws, goats, pigs)**
    - **Anthrax (sheep, goats, cattle)**
    - **Plague (rodents**
    - **Trichinosis (swine)**
    - **Rabies (fox, dogs, bats, racoons…)**

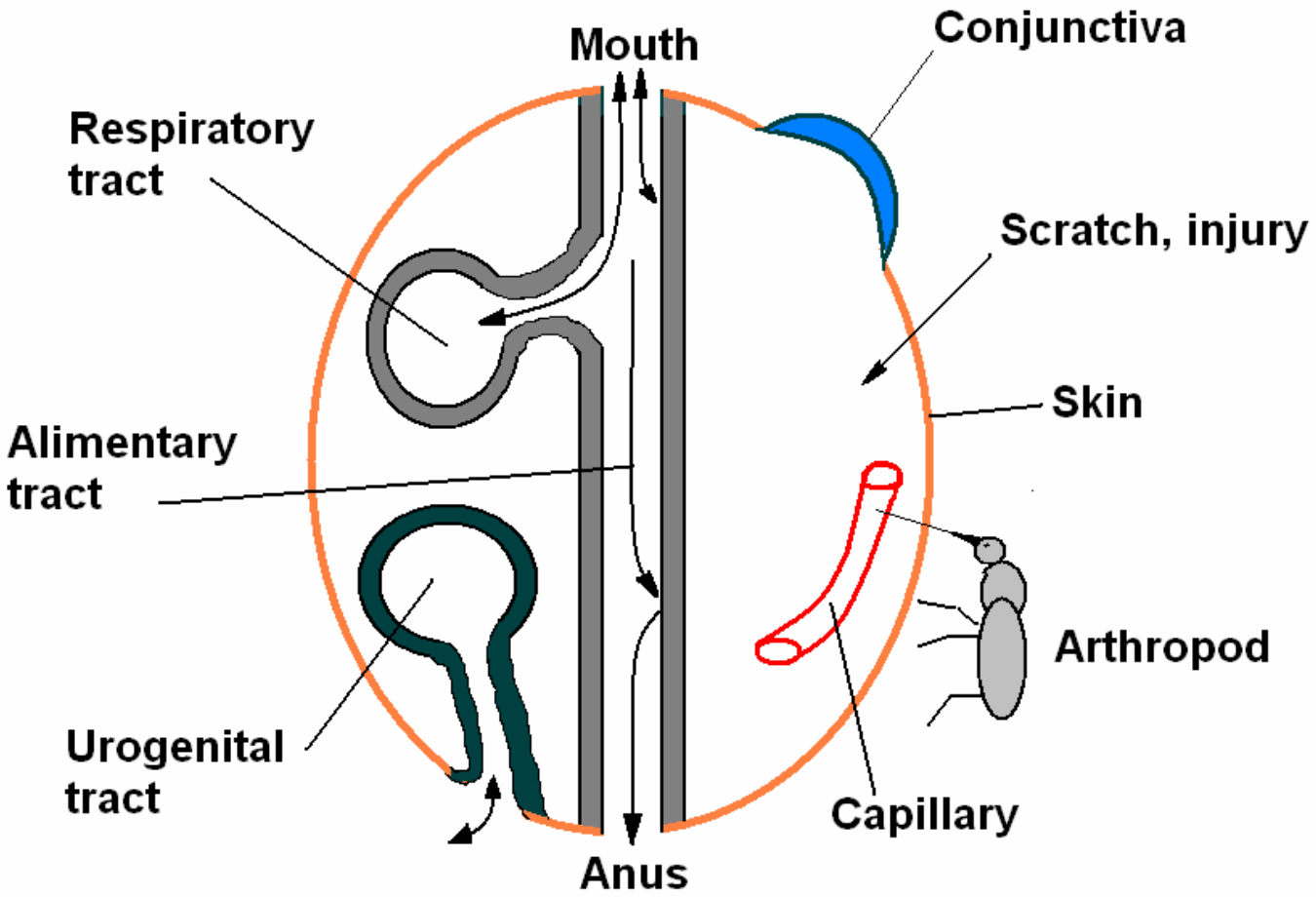
Chain of Infection

- Plants, soil, water reservoirs
  - Soil
    - Fungal agents – histoplasmosis
  - Water
    - Legionella pneumophila – Legionnaires' disease
      - Cooling towers, evaporative condensers, nebulizers
  - Plants
    - Wheat rust – ergot (Claviceps purpurea) – ergotism
    - Fungal agents - aflatoxins

- Cycles of infectious agent in nature
  - Man-man — Influenza
  - Man-arthropod-man — Malaria
  - Vertebrate-vertebrate-man — Psittakosis
  - Vertebrate-arthropod--vertebrate-man — Viral encephal.
  - Complex cycles
    - Helminth infections — River blindness

Chain of Infection

Portal of entry/exit in human host



Chain of Infection

- Portal of entry/exit in human host
  - Upper respiratory tract – Diphteria
  - Lower respiratory tract – Tuberculosis
  - Gastrointestinal tract – Typhoid fever
  - Genitourinary tract – Gonorrhea
  - Conjunctiva – Trachoma
  - Percutaneous – Leptospirosis
  - Percutaneous (bite artropod) – Yellow fever

Chain of Infection

Mode of transmission

- Any mechanism by which an infectious agent is spread from a source or reservoir to another person.
- Direct
  - Source and host share the same space at the same time
- Indirect
  - Source sheds an agent into environment and may not be present in the place where an infection happen.

Chain of Infection

Direct transmission

- Direct and essentially immediate transfer of infectious agent to a receptive portal of entry through which human or animal infection may take place.
  - Touching, kissing, biting, sexual intercourse
    - Mononucleosis, gonorhea
  - Direct projection (droplet spread) of droplet spray onto conjunctiva, mucous membranes of the eyes, nose or mouth.
  - Direct exposure of susceptible tissue to an agent in soil, compost, or decaying vegetable matter.
    - Clostridia, hookworm
  - Bite of animal
  - Transplacental transmission

Chain of Infection

Indirect transmission

- Vehicle-borne
- Vector-borne
  - Mechanical
  - Biological
- Airborne
  - Droplet nuclei
  - Dust

Chain of Infection

Vehicle-borne indirect transmission

- Contaminated inanimate material or objects
  - Toys, handkerchiefs, soiled clothes, bedding utensils, surgical instruments or dressings.
  - Water, food milk, biological products including blood, serum, plasma, tissues, or organs.
  - Any substances serving as an intermediate means by which an infectious agent is transported and introduced into a susceptible host through a suitable portal of entry.
  - The agent may or may not have multiplied or develop in or on the vehicle before being transmitted.

Chain of Infection

- **Mechanical vector-borne** indirect transmission
  - Includes simple mechanical carriage by a crawling or flying insect through soiling of its feet or proboscis.
  - Passage of agent through its gastrointestinal tract.
  - It does not require multiplication or development of organism.
  - Flies– Shigella, fleas - Yersinia pestis

Chain of Infection

- **Biological vector-borne** indirect transmission
  - Propagation, (multiplication) cyclic development, or combination of these is required before the arthropod can transmit the infective form of the agent to man.
  - Extrinsic incubation period
  - Agent may be passed vertically to succeeding generations (transovarian transmission)
  - Transstadial transmission is its passage from one stage of the life cycle to another, as nyph to adult.
  - Transmission may be by saliva during biting, by regurgitation or deposition on the skin of feces or other material capable of penetrating subsequently through the bite wound or through an area of trauma from scratching or rubbing. Transmission by an infected nonvertebrate host must be differentiated for epidemiologic purposes from simple mechanical carriage by a vector in the role of a vehicle. An arthropod in either role is termed a vector.
  - Malaria, Tick-borne encephalitis

Chain of Infection

- Airborne indirect transmission
  - The dissemination of microbial aerosols to a portal of entry, usually the respiratory tract.
    - Microbial aerosol are suspensions in the air of particles consisting partially or wholly of microorganisms. Particles in the range 1 – 5 μm range are easily drawn into the alveoli of the lungs and may be retained there.

Chain of Infection

- Airborne indirect transmission
  - Droplet nuclei
    - Residues that results from evaporation of fluid from droplets emitted by an infected host.
    - Droplet nuclei also may be created purposely by a variety of atomizing devices, or accidentally, as in microbiological laboratories or in abattoirs, rendering plants, or autopsy rooms.
    - They usually remain suspended in the air for long periods.

Chain of Infection

- Airborne indirect transmission
  - Droplet nuclei
    - The small particles of widely varying size that may arise from soil (fungus spores) or from clothes, bedding, or contaminated flors.

Chain of Infection

Host

- A person that affords subsistence or lodgment to an infectious agent under natural conditions.
- Genetic (constitutional) susceptibility
- General factors
  - Skin, mucous membranes, gastric acidity, cilia in respiratory tract, cough reflex
  - Nonspecific immune response
  - Malnutrition, alcoholism, disease, therapy
- Acquired specific immunity
  - Protective antibodies directed against a specific agent.
    - Active immunity - response to infection, vaccine, toxoid
    - Passive immunity – transplacental transfer from motherto fetus or by injectionof immune globuline

Implication for public health

Control of infectious diseases

- Knowledge of infection chain provides a base for effective control measure.
- Control measures are usually directed against the segment of infection chain that is most susceptible to intervention, unless practical issues dictate otherwise.

Implication for public health

Control of infectious diseases

- Control or elimination of agent at source
  - Isolation and treatment of patients with appropriate precation regarding relevant exit pathways.
  - Sanitation, disinfection in hospital settings

Implication for public health

Control of infectious diseases

- Measure directed against mode of transmission
  - Direct transmission
    - Source is treated or educated to avoid the specific type of contact associated with transmission
  - Vehicle-borne
    - Elimination or decontamination of vehicle
  - Fecal-oral transmission
    - Behavioral changes such as promoting of hand washing,
    - Rearrangement of the environment to reduce the risk of contamination

Implication for public health

Control of infectious diseases

- Measure directed against mode of transmission
  - Airborne diseases
    - Ventilation, air filtration…
  - Vector-borne disease
    - Control of vector
    - Prevention of exposure
      - Long pants and sleeves and/or use of insect repellants to reduce mosquito borne infections.

Implication for public health

Control of infectious diseases

- Measure directed against mode of transmission
  - Strategies protecting the portal of entry
    - Dentist's use of mask and gloves

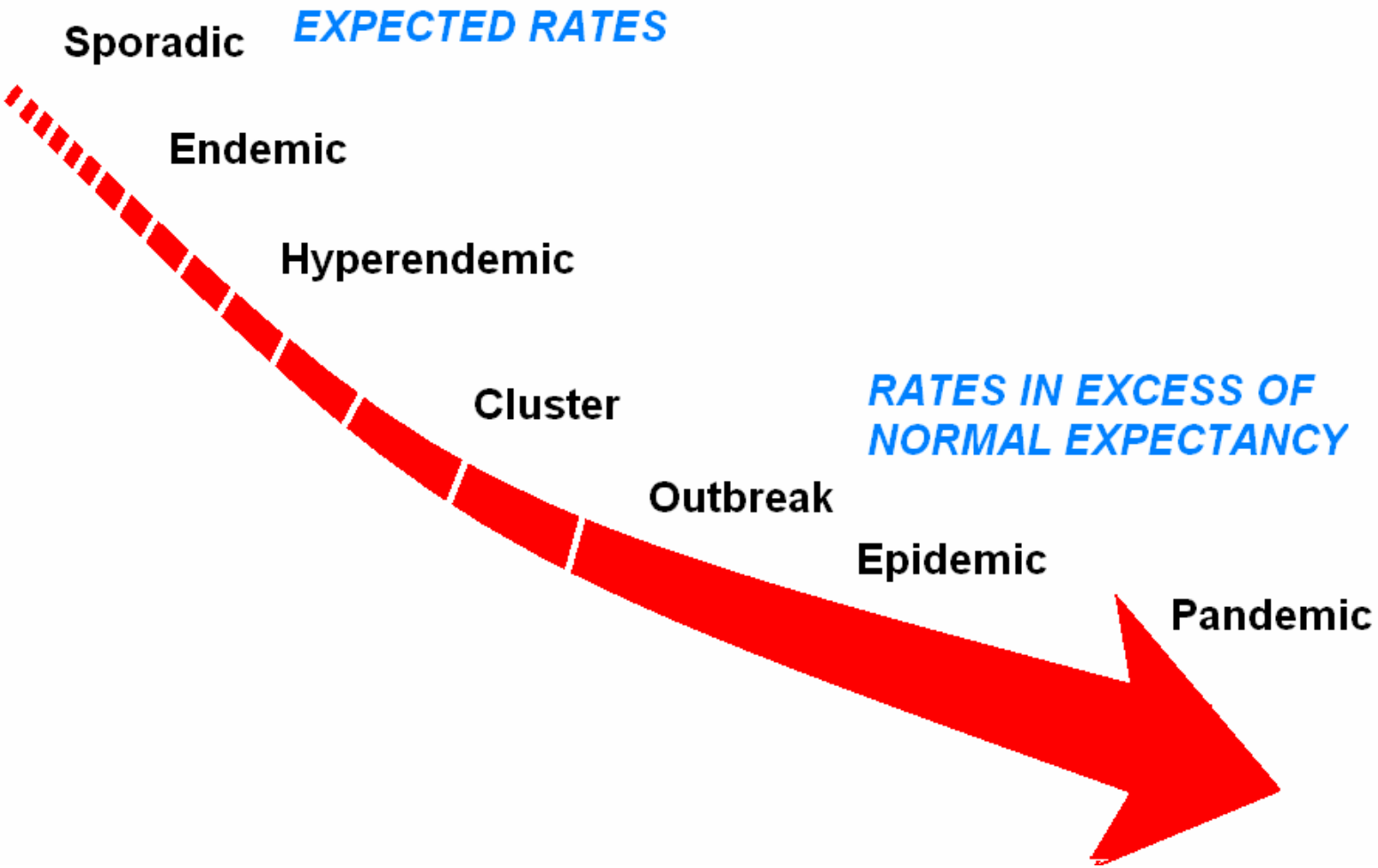
Implication for public health

Control of infectious diseases

- Measure aimed to increase host's defense
  - Nonspecific
  - Prophylactic administration of antibiotics to patients
  - Active immunization
  - Passive immunization

Epidemic disease occurrence

Levels of disease



Levels of disease

- Sporadic
  - Disease occurring infrequently and irregularly
- Endemic
  - Constant presence and/or usual prevalence of a disease in population within geographical area
- Hyperendemic
  - Persistent high levels of disease occurrence

Levels of disease

- Cluster
  - Aggregation of cases grouped in place and time that are suspected to be greater than the expected number. Often, however, the expected number is not known.
- Outbreak
  - As epidemic but is often used for a more limited geographic area.
- Epidemic
  - Often sudden increase in case of disease above what is normally expected in the population in given area.
- Pandemic
  - Epidemic that has spread over several countries or continents, usually affecting a large number of people.

Epidemics

- Occurrence
  - When an agent and susceptible hosts are present in adequate numbers, and the agent can be effectively conveyed from a source to the susceptible hosts because of favorable environment.

Epidemics

- Result from:
  - A recent increase in amount or virulence of the agent.
  - The recent introduction of the agent into settings where it has not been before.
  - An enhanced mode of transmission so that more susceptible person are exposed.
  - An environment conducive to interaction between host and the agent.
  - A change in the susceptibility of the host response to the agent.
  - Factors that increase host exposure or involve introduction through new portals of entry.

Epidemic pattern

- Classification of epidemics according to their manner of spread:
  - Common source
    - Point
    - Intermittent
    - Continuous
  - Propagated
  - Mixed
  - Other

Epidemic pattern

Common source outbreak

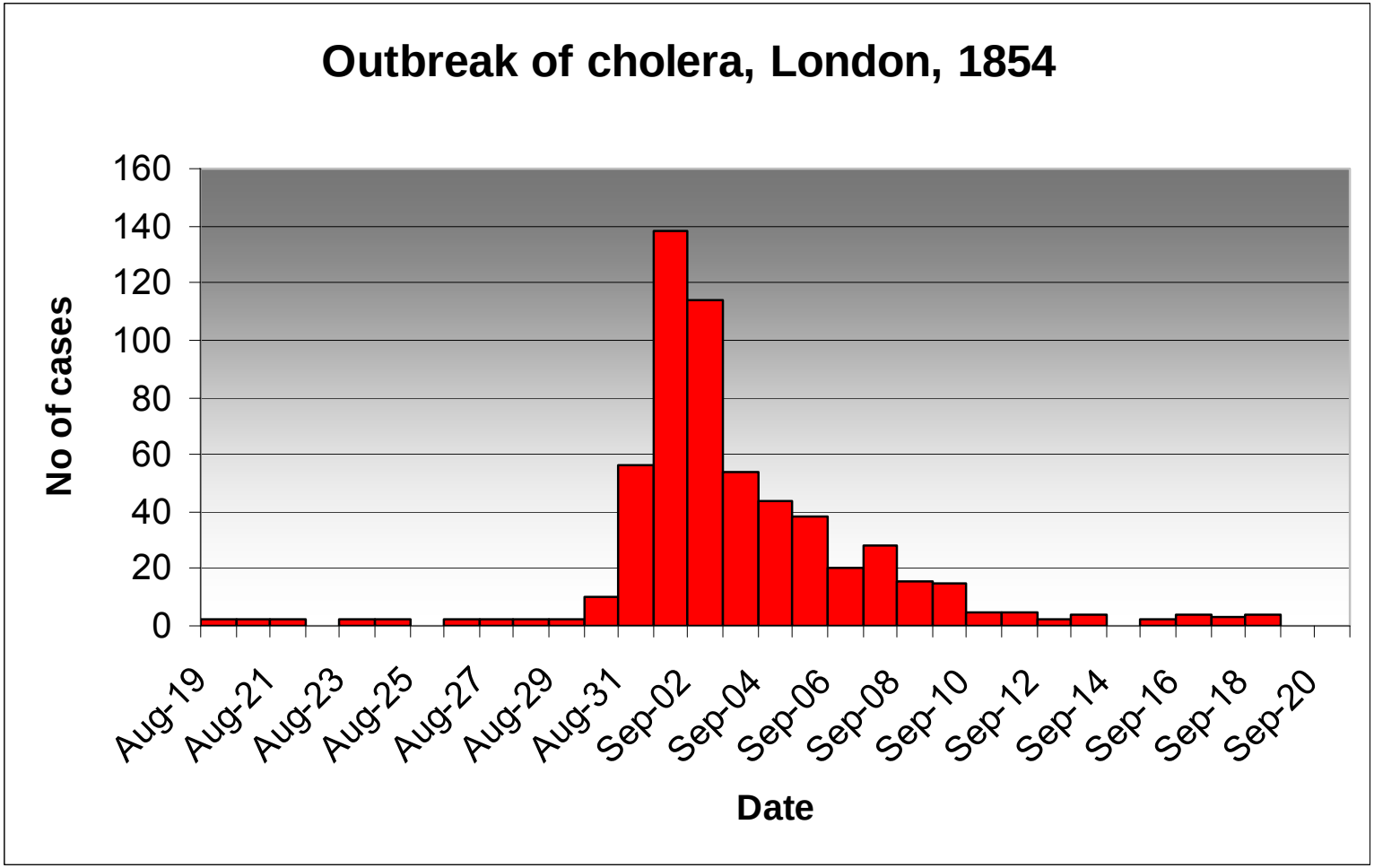
- Persons are exposed to a common agent.
- **Point**
  - Short term exposure
    - Everyone who becomes ill develops disease at the end of an incubation period.
      - Salmonellosis, Campylobactriosis, Hepatitis A,
    - Typical epidemic curve
      - Steep upslope, more gradual downslope (log-normal distribution)

Epidemic pattern

Common source outbreak

- Persons are exposed to a common agent.
- **Intermittent / continuous**
  - Exposure over days, weeks or longer.
    - Characteristic epidemic curves reflecting nature of intermittent exposure.
    - Wide and low peak in case of continuous exposure.

Point-source epidemic



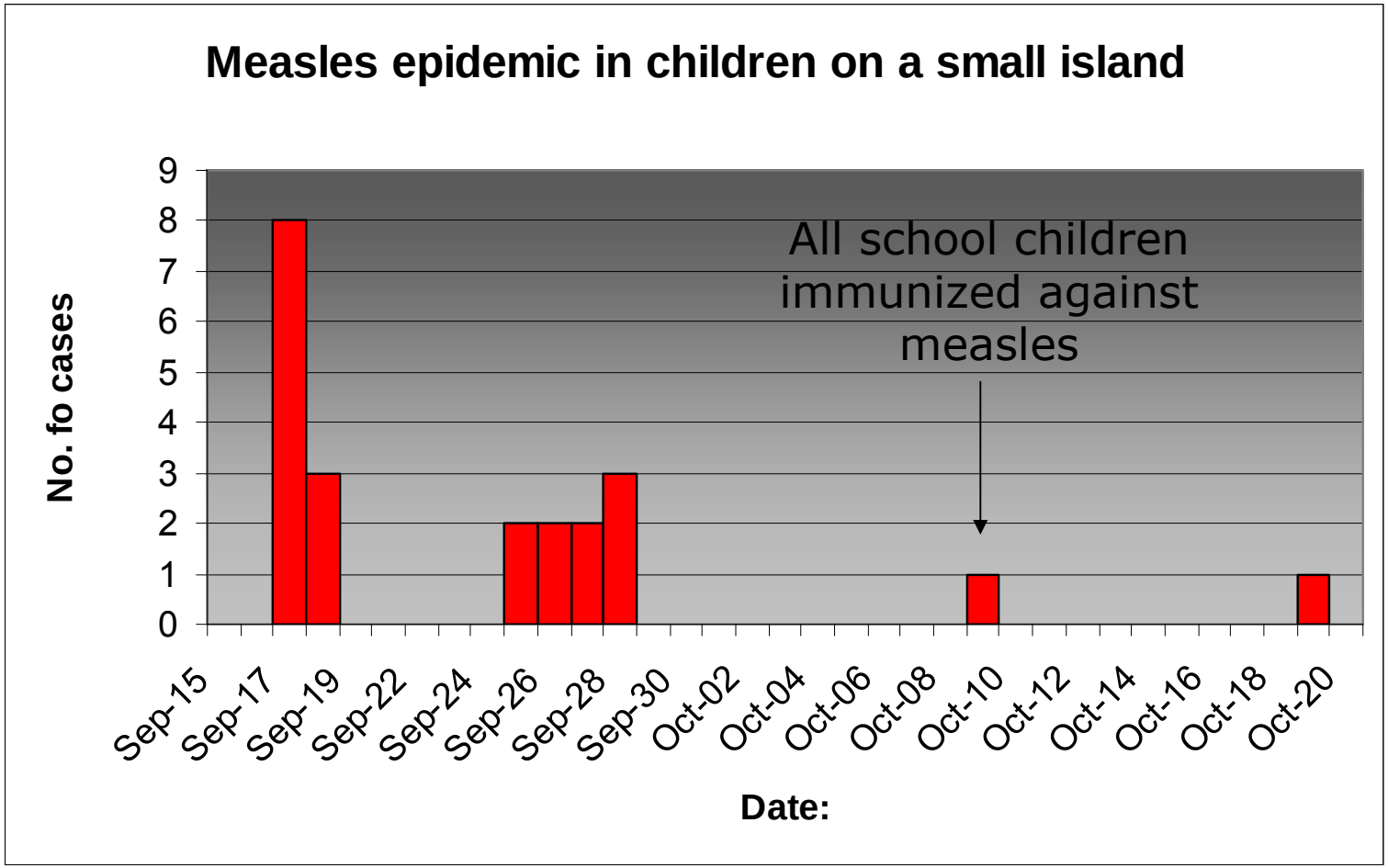
Source: Snow, 1855

Epidemic pattern

Propagated outbreak

- Transmission person-to-person
  - Direct mode of transmission
    - Syphilis,
  - Vehicle-borne
    - Hepatitis B or HIV by sharing needles.
  - Vector-borne
    - Yellow fever and mosquitoes
- Cases occurs over more than one incubation period
- Wanes after a few generations
  - Decrease in susceptible persons / effective intervention

Contagious epidemic



Source: Gao and Malison, 1988

Epidemic pattern

- Mixed epidemics
  - Have features of both common source epidemics and propagated epidemics.
  - The pattern of common source epidemic is followed by person-to person spread
  - Shigellosis

Epidemic pattern

- Other epidemics
  - Neither common source in its usual sens nor propagated from person to person
  - Zoonosis
  - Vector borne disease
  - Lyme disease (Borelliosis),

Control of communicable disease epidemics

- Management and control
  - Treating the cases
  - Preventing further spread of disease
  - Monitoring of the effects of control measures

Control of communicable disease epidemics

- Control measures can be directed
  - Against the source of infection
  - Against process of transmission/spread of disease
  - Towards protecting exposed people

Control of communicable disease epidemics

- Measure against the source
  - Isolation
    - Separation, for the period of communicability, of infected persons or animals from others under such conditions as to prevent or limit the transmission of the infectious agent from those infected to those who are susceptible of who may spread the agent to others.

Control of communicable disease epidemics

- Measure against the source
  - Isolation categories:
    1. Strict isolation
    2. Contact isolation
    3. Respiratory isolation
    4. Tuberculosis isolation
    5. Enteric precautions
    6. Drainage/secretion precautions
    7. Blood/body fluid precautions

Control of communicable disease epidemics

- Measure against the source
  - Quarantine
    - Restriction of the activities of well persons or animals who have been exposed to a case of communicable disease during its period of communicability (i.e., contacts) to prevent disease transmission during the incubation period if infection should occur.

Control of communicable disease epidemics

- Measure against the source
  - Absolute/complete quarantine
    - The limitation of freedom of movement of those exposed to a communicable disease for a period of time not longer than the longest usual incubation period of these disease, in such manner as to prevent effective contact with those not so exposed.

Control of communicable disease epidemics

- Measure against the source
  - Modified quarantine
    - A selective, partial limitation of freedom of movement of contacts, commonly on the basis of known or presumed differences in susceptibility and related to the danger of disease transmission. It may be designed to meet particular situations.

Control of communicable disease epidemics

- Measure against the source
  - Modified quarantine
    - Exclusion
      - Exclusion of children from school, exemption of immune persons.
      - Exclusion of food handlers with diarrhea.
    - Personal surveillance
      - Close medical or other supervision of contact in order to permit prompt recognition of infection or illness but without restricting movements
    - Segregation
      - Separation of some part of group of persons or domestic animals from the others
        - Removing of susceptible children to homes of immune persons
        - Establishment of a sanitary boundary to protect uninfected from infected portion of population.

Control of communicable disease epidemics

- Measures against the reservoir
  - Legionellosis
    - Design, maintenance and monitoring of water systems: store hot water over 60°C; store and deliver cold water under 20°C.
    - Maintenance and hygiene of wet cooling systems.
    - Disinfection, regular cleaning and changing of water in indoor fountains,
    - Use of sterile water for respiratory therapy device

Control of communicable disease epidemics

- Measures against the reservoir
  - Rabies
    - Oral vaccination of foxes (using baits), the principal reservoir in Europe.
    - Vaccination of domestic animals.
  - Brucellosis
    - Mass testing, with slaughter of infected herds
    - Vaccination of cattle
  - Salmonellosis
    - Reduction of infections and carriage in food animals, particularly in poultry.

Control of communicable disease epidemics

- Measure against exposure pathway
  - Direct transmission
    - Sexually transmitted disease
      - Health and sex education to discourage multiple sexual partners and casual sexual activity and to promote correct and consistent use of condoms.
    - Influenza
      - Education towards desirable behavioral changes: basic personal hygiene to reduce transmission by coughing, sneezing or contaminated hands
      - Avoiding crowded places.
      - Ventilation of rooms…

Control of communicable disease epidemics

- Measure against exposure pathway
  - Indirect transmission
    - Vehicle-borne
      - Salmonellosis
        - Commercial food processing should be subject to the HACCP (Hazard Analysis Critical Control Point)
        - Use only pasteurized eggs and milk
        - Adequate cooking of meat and poultry
        - Practices to avoid cross-contamination
        - Routine home and personal hygiene
      - Campylobacteriosis, Botulism, Bacillus cereus…

Control of communicable disease epidemics

- Measure against exposure pathway
  - Indirect transmission
    - Vector-borne
      - Malaria
        - Prevention of mosquito bites (Sleep in safe, fully air-conditioned accommodation, bet nets, use of pyrethroids, mosquito repellents, long sleeves and trousers .
        - Diminishing or r eradication of vector (spraying of houses, destruction of larval sites by removing standing water.
      - Tick-borne encephalitis, Yellow fever….

Control of communicable disease epidemics

- Measure against exposure pathway
  - Indirect transmission
    - Air-borne
      - Influenza, Tuberculosis
      - Coxiella burnetti (Q fever)
        - The ID_{50} is one via inhalation, the most infectious organism known to man.

Control of communicable disease epidemics

- Measure aimed to increase host's defense
  - Nonspecific
    - Nourishment…
  - Prophylactic administration of antibiotics to patients
    - Malaria, tuberculosis
  - Active immunization
    - Tuberculosis, Diphtheria, Pertussis, Tetanus (DiTePe), Measles, Mumps, Rubella (MMR vaccine), Hepatitis A, Hepatitis B, Haemophilus influenzae,
  - Passive immunization
    - Tetatnus, Hepatitis A