

## DISEASE DETECTIVES – PART ONE

### BACKGROUND & SURVEILLANCE

#### Clinical Approach vs. Public Health Approach to Health Care

- **Clinical Approach** – *primary role is diagnosis and treatment of illness in individuals, preventive medicine* (e.g., immunizations, smoking cessation, obesity counselling and other behavioral/lifestyle concerns) has only been addressed recently ó focus remains on the individuals.
- **Public Health Approach** ó *primary role is in control and prevention of disease in populations or groups of individuals*, some activities (e.g., diagnosing cases associated with outbreaks and treating persons with communicable diseases such as tuberculosis or syphilis) may overlap with those in clinical medicine.
- There are notable differences between the two disciplines of clinical medicine and public health.

	Public Health	Clinical Medicine
<b>Primary Focus</b>	<b>Populations</b>	<b>Individuals</b>
<b>Emphasis</b>	Prevention	Diagnosis
	Health Promotion	Treatment
	Whole Community	Whole Patient
<b>Paradigm</b>	Interventions aimed at Environment, Human Behavior and Lifestyle, and Medical Care	Medical Care
<b>Organizational Lines of Specialization</b>	Analytical (Epidemiology);	Organ (Cardiology);
	Setting and Population (Occupational Health);	Patient Group (Pediatrics);
	Substantive Health Problem (Nutrition);	Etiology, Pathophysiology (Oncology, Infectious Disease)
	Skills in Assessment, Policy Development, and Assurance	Technical Skill (Radiology)

[Adapted from: Fineberg, Harvey, MD, PhD, Dean, Harvard University School of Public Health, 1990. Traditional Distinctions Between Public Health and Medicine. Table 5-1, Who Will Keep the Public Healthy? Educating Public Health Professionals for the 21st Century. Institute of Medicine, 2003.]

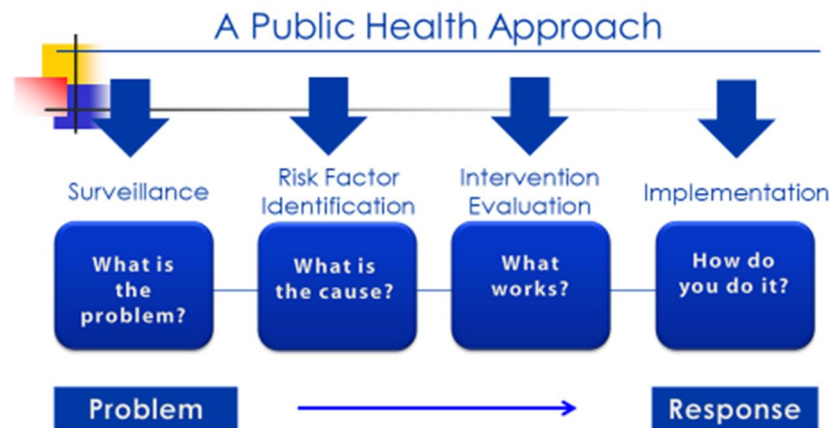
## Selected History of Epidemiology and Population Health

- Circa 400 B.C. - Epidemiology's roots are nearly 2500 years old. **Hippocrates** attempted to explain disease occurrence from a rational rather than a supernatural viewpoint.
- 1662 - **John Graunt**, a London haberdasher and councilman published a landmark analysis of mortality data in 1662.
- 1740s **James Lind** designed first experiment to use a concurrently treated control group while studying scurvy; determined limes could prevent scurvy; British sailors became known as "limeys"
- 1790s- **Edward Jenner** developed the small pox vaccine using clinical trials using cowpox
- 1800 - **William Farr** built upon Graunt's work by systematically collecting and analyzing Britain's mortality statistics. Farr, considered the father of modern vital statistics and surveillance, developed many of the basic practices used today in vital statistics and disease classification.
- 1849-54- **John Snow** the "father of field epidemiology." formed and tested hypothesis on the origin of cholera as waterborne transmission in London - one of the first studies in analytic epidemiology
- 1880s- **Louis Pasteur** recognized the bacterial cause and developed a vaccine for anthrax
- 1843-1910- **Robert Koch** – formalized standards (postulates) to identify organisms with infectious diseases
- 1910's - Flu pandemic
- 1920 - **Joseph Goldberger** published a descriptive field study showing the dietary origin of pellagra
- 1940's - Fluoride supplements added to public water supplies in randomized community trials
- 1949 - Initiation of the Framingham study of risk factors for cardiovascular disease
- 1950 - Epidemiological studies link cigarette smoking and lung cancer, demonstrating the power of case-control study design
- 1954 - Field trial of the Salk polio vaccine - the largest formal human experiment
- 1959 - **Mantel and Haenszel** develop a statistical procedure for stratified analysis of case-control studies
- 1960 - **MacMahon** published first epidemiologic text with a systematic focus on study design
- 1964 - US Surgeon General's Report on Smoking and Health establish criteria for evaluation of causality
- 1970's - Large community based trials implemented, such as North Karelia and Stanford Three Communities; worldwide eradication of smallpox
- 1980's - Chronic disease, injury and occupational epidemiology; HIV epidemic
- 1990's; **Edward Sydenstricker** (early 1900s) became a pioneer public health statistician  
Behavioral risk factor epidemiology; prevention of adverse health outcomes through policies and regulations; national programs in breast and cervical cancer prevention; tobacco epidemiology; emerging infectious diseases; criticism of epidemiology for being inconsequential ('small' risk ratios); standardization of surveillance methods; Mad cow disease (BSE) in England and Europe; variant Creutzfeld-Jacob disease; aging of USA; disaster epidemiology
- 2000's - Genetic and molecular epidemiology; health disparities; racialism; HIPAA in the USA; West Nile Virus
- 2001 - 9/11
- 2002 - bioterrorism; anthrax and smallpox threat and vaccinations
- 2003 - SARS, quarantines and public health law; and world-wide epidemiology; BSE in Canada
- 2004 - SARS recurrence; BSE in USA; flu epidemic
- 2009--2009 H1N1 pandemic

# Main Components of Public Health Approach – Problem to Response

Public health problems are diverse and can include:

- infectious diseases
- chronic diseases
- emergencies
- injuries
- environmental health problems
- other health threats



(from CDC-Public Health 101 Series)

**Surveillance-** What is the problem or Is there a problem?

**Risk Factor Identification-** What is the cause?

**Intervention Evaluation-** What works?

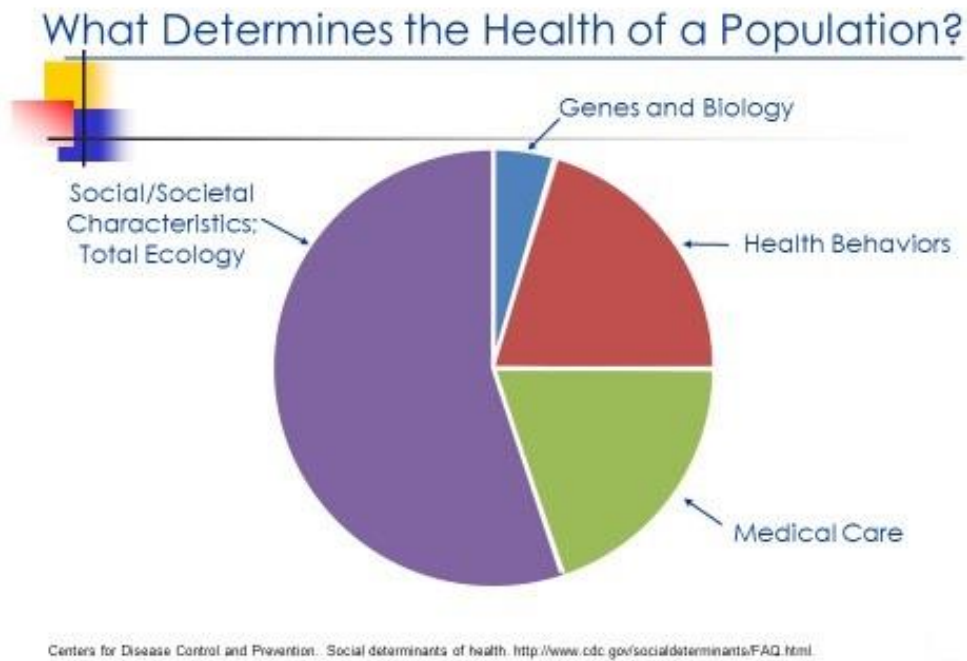
**Implementation-**How do you do it?

## Key Terms in Public Health

- **clinical care:** prevention, treatment, and management of illness and the preservation of mental and physical well-being through the services offered by medical and allied health professions=also known as *health care*.
- **determinant:** factor that contributes to the generation of a trait.
- **epidemic or outbreak:** occurrence in a community or region of cases of an illness, specific health-related behavior, or other health-related event clearly in excess of normal expectancy. Both terms are used interchangeably; however, *epidemic* usually refers to a larger geographic distribution of illness or health-related events.
- **health outcome:** result of a medical condition that directly affects the length or quality of a person's life.

## Health Determinants

- Genes and biology
- Health behaviors
- Social and societal characteristics
- Access to and use of health services and medical care



(from CDC-Public Health 101 Series)

- This chart is an estimate of how these four major determinants influence health at the population level.
- Trillions of dollars are spent on health care, yet it only determines about 25% of our health.
- The remaining 75% of what determines our health as a population is our total environment or ecology, including the social environment in which we live, plus our health behaviors and to a lesser extent, our genes and biology.
- An example of the role these determinants play in our daily lives is through nutrition and physical activity. Both are essential elements in producing optimal health and should be viewed in the context of such environmental factors as
  - social and cultural norms that influence food choices and physical activity,
  - environmental characteristics, such as availability (lack of healthy food, open space for exercise, or safety in urban neighborhoods), and
  - sector influences, such as the marketing of processed food.
- All of these factors influence our individual choices, which in turn, influence our overall health.

# Public Health Core Sciences



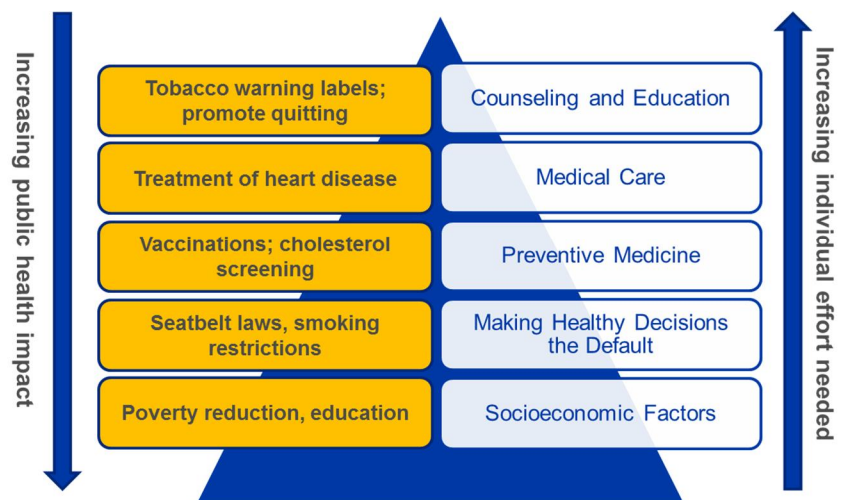
(from CDC-Public Health 101 Series)

## Major Types of Public Health Issues in the US

The CDC's Prevention Status Report lists the 10 most important public health problems and concerns are (listed alphabetically):

- Alcohol-related harms
- Food safety
- Healthcare-associated infections
- Heart disease and stroke
- HIV
- Motor vehicle injury
- Nutrition, physical activity and obesity
- Prescription drug overdose
- Teen pregnancy
- Tobacco use

## Health Impact Pyramid



Frieden TR. Framework for public health action: the health impact pyramid. Am J Public Health 2010;100:590. 5.

## Epidemiology and Its Role in Public Health

**Epidemiology** ó the disease detectives who work to solve public health issues

- Definition-*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 problem*
- Purposes of Epidemiology in Public Health Practice
  - Determine the agent, host, and environmental factors that affect health
  - Determine the relative importance of causes of illness, disability, and death
  - Identify those segments of the population that have the greatest risk from specific causes of ill health
  - Evaluate the effectiveness of health programs and services in improving population health
- Types of disease agents ó biologic, physical, and chemical

### Steps in Solving Health Problems

Step 1-Collect Data ó Surveillance, determine Time/Place/Person triad

Step 2- Assessment- Inference

Step 3- Hypothesis testing ó Determine how and why

Step 4- Action-Intervention

**Descriptive Epidemiology** involves identifying to the time, place, and the person involved in the onset of the health-related event.

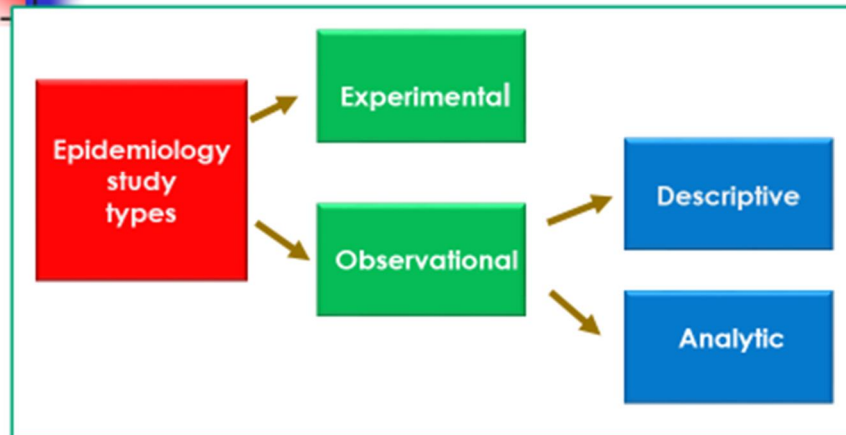
**Analytical Epidemiology** is mainly concerned with finding the causes of the health-related event and to identify the interventions of the health problem.

Descriptive and Analytic Epidemiology	
Descriptive epidemiology	Analytic epidemiology
When was the population affected?	How was the population affected?
Where was the population affected?	Why was the population affected?
Who was affected?	

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Descriptive vs Analytical Epidemiology	
<b>Descriptive Epidemiology</b> refers to the studies that generate hypotheses and answer the questions who, what, when and where of the disease or infection.	<b>Analytic Epidemiology</b> refers to the studies that are conducted to test for hypotheses and to generate conclusions on the particular disease.
Hypothesis	
Descriptive epidemiology is able to generate a hypothesis.	Analytic epidemiology is able to conduct a test for the hypothesis.
Interventions	
Intervention studies are not performed in descriptive epidemiology.	Interventions are analyzed in analytic epidemiology.

# Epidemiology Study Types

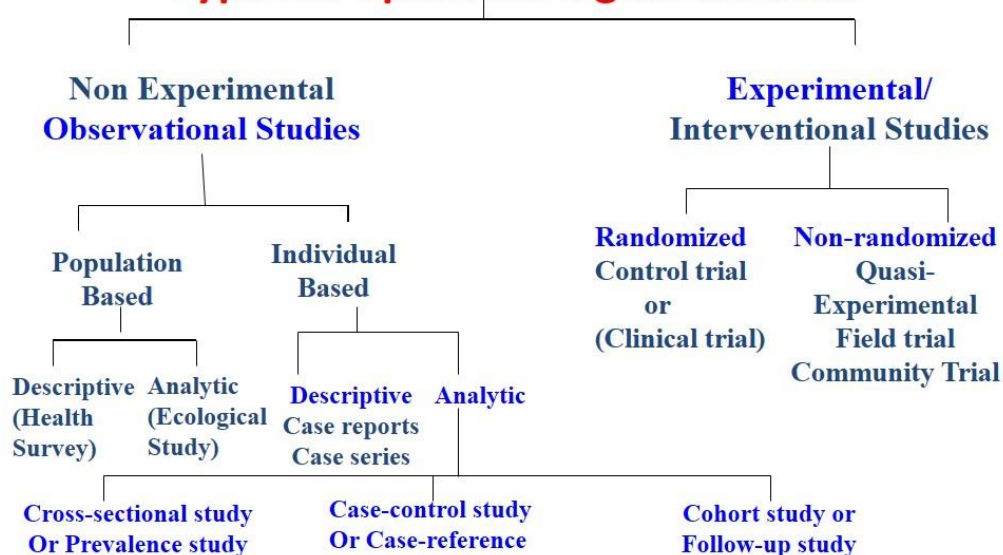


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- In an **Experimental Study**, the investigators can control certain factors within the study from the beginning. An example of this type is a vaccine efficacy trial that might be conducted by the National Institutes of Health. In such a trial, the investigators randomly control who receives the test vaccine and who does not among a limited group of participants; they then observe the outcome to determine if it should be used more widely.
- In an **Observational Study**, the epidemiologist does not control the circumstances. These studies can be further subdivided into descriptive and analytic.
  - In a **Descriptive Study**, the epidemiologist collects information that characterizes and summarizes the health event or problem.
  - In the **Analytic Study**, the epidemiologist relies on comparisons between different groups to

determine the role of different causative conditions or risk factors.

## Types of Epidemiological Studies



## Basic Epidemiology Terms – Disease Frequency

- **Endemic** ó disease or condition present among a population at all times
- **Outbreak** ó (localized epidemic) ó more cases of a particular disease than expected in a given area or among a specialized group of people over a particular period of time.
- **Epidemic** ó large numbers of people over a wide geographic area affected.
- **Pandemic** -An epidemic occurring over a very wide area (several countries or continents) and usually affecting a large proportion of the population.
- **Cluster** óan aggregation of cases over a particular period esp. cancer & birth defects closely grouped in time and space regardless of whether the number is more than the expected number. (often the expected number of cases is not known.)
- **Sporadic** ó a disease that occurs infrequently and irregularly



- **risk** - The probability that an individual will be affected by, or die from, an illness or injury within a stated time or age span.
- **rate** ó number of cases occurring *during a specific period*; always dependent on the size of the population during that period.
- **ratio** ó value obtained by dividing one quantity by another ó a ratio often compares two rates.
- **proportion** ó the comparison of a part to the whole as the number of cases divided by the total population ó *does not have a time dimension*, It can be expressed as a decimal, a fraction, or a percentage.

$$\text{Rate (\%)} = \frac{\text{number of cases}}{\text{population at risk}} \times 100$$

### Symbiotic Relationships between organisms:

- **Normal flora** – Many microbes have a positive symbiotic relationship with other organisms.  
**Mutualism** ó both organisms benefit.
- **Commensalism** – one organisms and the other is not harmed or helped.
- **Parasitism** is the condition (one organism is helped and the other is harmed) which takes place when humans are invaded by infectious microbes. A parasite-host relationship is created. The parasite is often called the **infectious agent**.

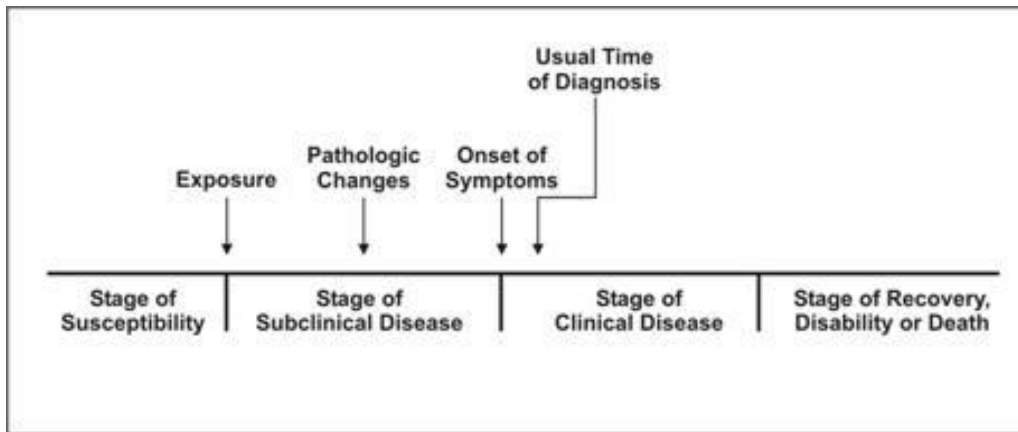
# Natural History and Spectrum of Disease

(CDC Self-Study Course SS1978 Lesson 1)

Natural history of disease refers to the progression of a disease process in an individual over time, in the absence of treatment.

Many, if not most, diseases have a characteristic natural history, although the time frame and specific manifestations of disease may vary from individual to individual and are influenced by preventive and therapeutic measures.

Natural History of Disease Timeline



Timeline shows state of susceptibility, exposure, subclinical disease in which pathologic changes takes place, onset of symptoms, followed by usual time of diagnosis, clinical disease, followed by recovery, disability, or death.

The process begins with the appropriate exposure to or accumulation of factors sufficient for the disease process to begin in a susceptible host. For an infectious disease, the exposure is a microorganism. For cancer, the exposure may be a factor that initiates the process, such as asbestos fibers or components in tobacco smoke (for lung cancer), or one that promotes the process, such as estrogen (for endometrial cancer).

After the disease process has been triggered, pathological changes then occur without the individual being aware of them.

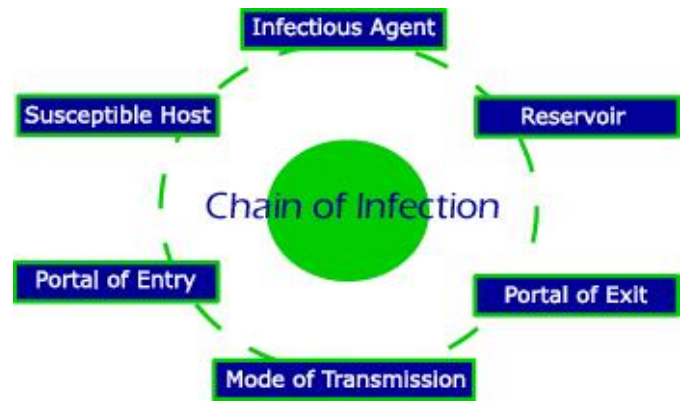
This stage of subclinical disease, extending from the time of exposure to onset of disease symptoms, is usually called the **incubation period** for infectious diseases, and the **latency period** for chronic diseases.

During this stage, disease is said to be asymptomatic (no symptoms) or inapparent. This period may be as brief as seconds for hypersensitivity and toxic reactions to as long as decades for certain chronic diseases.

Even for a single disease, the characteristic incubation period has a range. For example, the typical incubation period for hepatitis A is as long as 7 weeks. The latency period for leukemia to become evident among survivors of the atomic bomb blast in Hiroshima ranged from 2 to 12 years, peaking at 667 years.

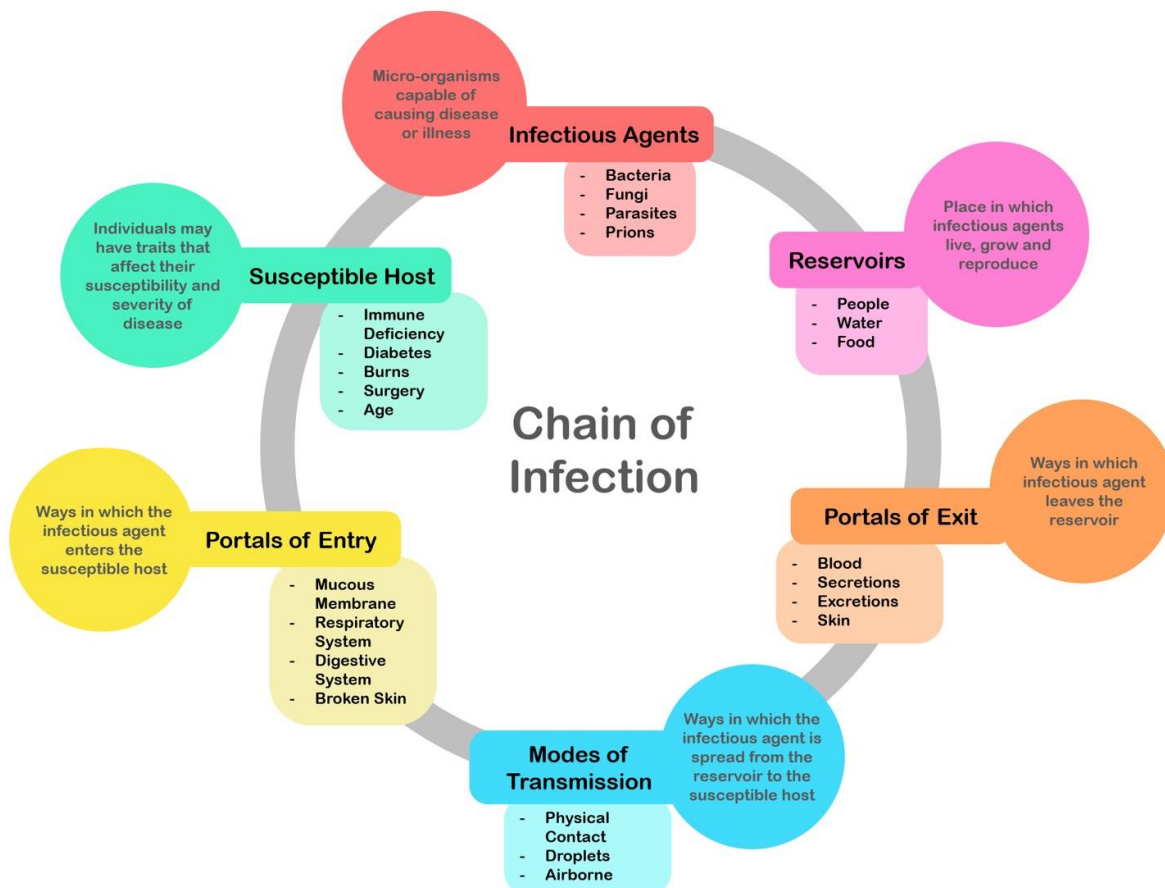
## MECHANISM OF DISEASE

### CHAIN OF INFECTION



The diagram above is a model used to understand the infection process. Each link in the chain must be present and in the correct sequential order for an infection to occur.

1. **Agent** - a microbial organism with the ability to cause disease
2. **Reservoir** - a place where agents can thrive and reproduce
3. **Portal of exit** - a place of exit providing a way for an agent to leave the reservoir
4. **Mode of transmission** - method of transfer by which the organism moves or is carried from one place to another
5. **Portal of Entry** - an opening allowing the microorganism to enter the host
6. **Susceptible host** – a person who cannot resist an microorganism invading the body, multiplying and resulting in infection



## CHARACTERISTICS OF THE ELEMENTS

- **vector** - an animate intermediary in the indirect transmission of an agent that carries the agent from a reservoir to a susceptible host. An organism that transmits the infection as a mosquito transmits the malaria protozoans.
- **fomite** - a physical object that serves to transmit an infectious agent from person to person.
- A comb infested with one or more head lice would be a fomite or the dust particles containing infectious cold virus that remain after droplets of infected saliva are coughed into the air.
- **zoonosis** - An infectious disease that is transmissible from animals to humans.
- Microbes which can be infectious agents include **bacteria, viruses, fungi, protozoa, algae, parasitic worms, and other pathogenic agents as prions.**
- Persons more vulnerable to becoming susceptible hosts include the young, the elderly, and people with weakened immune systems.
- Environments which bring the agent and host together **might involve such things as contaminated food that is ingested, an environment that allow a vector to introduce the agent into the host as a mosquito bite, air that allow an agent to be inhaled by a host or agents spread by contact between two people.**
- Sometimes there are organisms as insects, arthropods, or even mammals as dogs or bats who can act as **vectors** (organisms who allow the infecting agent to thrive, reproduce, and then act as the mode of transmission)
- **Infectious dose** - the amount of pathogen (measured in number of microorganisms) required to cause an infection in the host. Usually it varies according to the pathogenic agent and the consumer's age and overall health.
- **Period of communicability** - the **period** when you are infectious and can spread your germs (whether bacteria, viruses, or parasites) to an uninfected person

## CONDITIONS WITHIN THE HOST

- **Contamination** ó when a potentially infectious agent exists in the host but has not yet invaded the tissues of the host. The microbe may be destroyed by the body defenses or it may become part of the normal flora.
- **Infection** ó when the infectious agent begins its invasion of the host tissue and its rapid multiplication. The infection may be **localized** or it may spread to alternative sites as deeper organs or tissues becoming **systemic**
- **Disease** – when the cumulative effects of the infection cause damage in the tissues

Three terms are used to describe an infectious disease according to the various outcomes that may occur after exposure to its causative agent. ·

- **Infectivity** refers to the proportion of exposed persons who become infected. ·
- **Pathogenicity** refers to the proportion of infected persons who develop clinical disease. ·
- **Virulence** refers to the proportion of persons with clinical disease who become severely ill or die.

Terms used to describe the health issue.

**Incidence:** rate of occurrence of an event; number of new cases of disease occurring over a specified period of time; may be expressed per a known population size

**Prevalence:** number of cases of disease occurring within a population at any one given point in time

# Surveillance

*The ongoing, systematic collection, analysis, and interpretation of health-related data essential to planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those responsible for prevention and control*

## Goal of Public Health Surveillance

Provide information that can be used for health action by public health personnel, government leaders, and the public to guide public health policy and programs

## Purposes of Surveillance

- Assess public health status
- Define public health priorities
- Evaluate programs
- Stimulate research

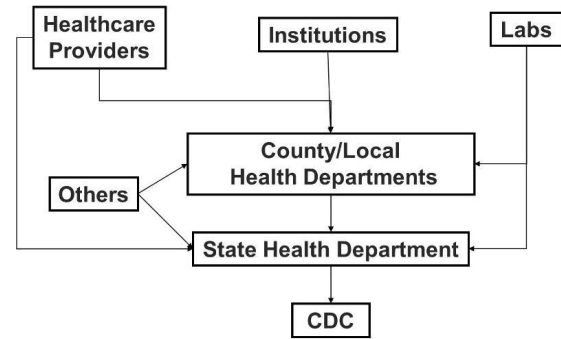
## Collaboration Partners

- 911 systems
- Ambulance services
- Federal agencies
- Hospitals
- Law enforcement agencies
- Nurse hotlines
- Poison control centers
- State and local public health agencies
- Veterinarians
- Agriculture
- Emergency management
- Health care providers
- Industry
- Medical examiners
- Pharmaceutical agencies
- Schools
- Urgent care and emergency departments

## Uses of surveillance

- Identify patients and their contacts for treatment and intervention
- Detect epidemics and other health problems
- Estimate magnitude and scope of a health problem
- Measure trends and characterize diseases
- Detect changes in health practices
- Monitor changes in infectious and environmental agents
- Assess effectiveness of programs and control measures
- Develop hypotheses and stimulate research

## Disease Reporting Pathway



# Public Health Surveillance Process

## 5 Step Process

1. Data Collection
  - Reported diseases or syndromes
  - Electronic health records (e.g., hospital discharge data)
  - Vital records (e.g., birth and death certificates)
  - Registries (e.g., cancer, immunization)
  - Surveys (e.g., National Health and Nutrition Examination Survey [NHANES])
2. Data Analysis
  - Data analysis by place is the usual method used to examine reports either by where the case was reported or, ideally, by where the illnesses occurred.
  - Data analysis by location allows prevention resources to be directed to where the exposure occurred.
3. Data Interpretation
  - Data Interpretation is closely coupled with data analysis.
  - By identifying the person, place, and time, one can more easily determine how and why the health event happened
4. Data Dissemination
  - Data dissemination describes how to distribute information to those who need to know.
  - Methods of distribution include
    - health agency newsletters, bulletins, or alerts
    - surveillance summaries and reports
    - medical and epidemiologic journal articles
    - press releases and social media
  - Target audiences can include
    - public health practitioners
    - clinicians and other health care providers
    - policy and other decision makers
    - community organizations
    - the general public
5. Link to Action - without action, the collected data serve no real purpose.

## Types of Surveillance

### • *Passive Surveillance*

- diseases are reported to health care providers
- simple and inexpensive
- limited by incompleteness of reporting and variability of quality
- **example**- a physician sees a patient, diagnoses measles, and then initiates a case report by contacting the local health department and providing the details as required for a case of measles. the local health department relies on the physician to report the case.

### • *Active Surveillance*

- health agencies contact health providers seeking reports
- ensures more complete reporting of conditions
- used in conjunction with specific epidemiologic investigation
- are most appropriate for epidemics or where a disease has been targeted for elimination
- **Example**-if a health department receives a case report for measles, a serious vaccine-preventable disease, active surveillance will be triggered. Public health practitioners will actively search for other cases, using a standard case definition: calling doctors' offices for any cases, following up to find additional cases among those exposed, checking laboratories.

### • *Sentinel*

- Reporting of health events by health professionals who are selected to represent a geographic area or a specific reporting group
- Is used when high-quality data are needed about a particular disease that cannot be obtained through a passive system
- Can be active or passive
- Monitoring trends or key health indicators
- Involves only a limited network of carefully selected reporting sites
- Data collected in a well-designed sentinel system can be used to signal trends, identify outbreaks and monitor the burden of disease in a community, providing a rapid, economical alternative to other surveillance methods.
- Because sentinel surveillance is conducted only in selected locations, however, it may not be as effective for detecting rare diseases or diseases that occur outside the catchment areas of the sentinel sites.
- The sentinel may be a disease, an event. or a population
- **Example**, a network of large hospitals might be used to collect high-quality data on various diseases and their causative organisms, such as invasive bacterial disease caused by *Haemophilus influenzae* type b, meningococcus or pneumococcus.

- ***Syndromic Surveillance***

- Focuses on one or more symptoms rather than a physician-diagnosed or laboratory-confirmed disease
- Is the analysis of medical data to detect or anticipate disease outbreaks
- Has been historically used to target the investigation of potential cases
- Its use for detecting outbreaks associated with bioterrorism is increasingly being explored by public health officials
- **Example:** Influenza outbreak
  - Using a normal influenza outbreak as an example, once the outbreak begins to affect the population, some people may call in sick for work/school, others may visit their drug store and purchase medicine over the counter, others will visit their doctor's office and other's may have symptoms severe enough that they call the emergency telephone number or go to an emergency department.
  - Syndromic surveillance systems monitor data from school absenteeism logs, emergency call systems, hospitals' over-the-counter drug sale records, Internet searches, and other data sources to detect unusual patterns. When a spike in activity is seen in any of the monitored systems disease epidemiologists and public health professionals are alerted that there may be an issue.