

# EPIDEMIOLOGY



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## EPIDEMIOLOGY KEY TERMS

- **Epidemic or Outbreak:** disease occurrence among a population that is in excess of what is expected in a given time and place.
- **Cluster:** group of cases in a specific time and place that might be more than expected.
- **Endemic:** disease or condition present among a population at all times.
- **Pandemic:** a disease or condition that spreads across regions.

# **EPIDEMIOLOGY KEY TERMS**

- **Contamination**

- The presence of an infectious agent on a body surface, on or in clothes, beddings, toys, surgical instruments or dressings, or other articles or substances including water and food

- **Infestation**

- It is the lodgment, development and reproduction of arthropods on the surface of the body or in the clothing, e.g. lice, itch mite, invasion of gut by parasites e.g. round worms.

- **Contagious Disease**

- A contagious disease is the one that is transmitted through contact e.g. scabies, trachoma, sexually transmitted disease and leprosy.

# INFECTION

- Definition of Infection.

- Infection is the entry and development or multiplication of an infectious agent in the body of man or animals.
- An infection does not always cause illness.
- Gradients of infection:
  - ✓ Colonization (S. Aureus in skin and normal nasopharynx)
  - ✓ Subclinical or inapparent infection (Polio)
  - ✓ Latent infection (Herpes Simplex)
  - ✓ Manifest or clinical infection

## TYPES OF CASES

- Case

- Defined as “a person in the population or study group identified as having the particular disease, health disorder, or condition under investigation”

- Confirmed Case

- Meets the clinical description and criteria for laboratory confirmation
- Classified as definitive for surveillance purposes and is laboratory confirmed by one or more tests
- May fulfill the described clinical case definition or not.
- If testing is unavailable or limited, confirmed case counts will not reflect the true burden of disease

## **TYPES OF CASES**

- **Probable Case.**

- Refers to an individual displaying clinical signs and symptoms consistent with a specific disease or condition and meets certain criteria outlined.
- Might not have undergone confirmatory laboratory testing or may have inconclusive test results

- **Possible Case.**

- Refers to an individual exhibiting signs and symptoms that could potentially indicate a particular disease or condition, but who does not meet all the specific criteria required for a definitive diagnosis according to a given case definition.
- Often categorized when there is uncertainty about the presence of certain diagnostic factors, or when additional information or testing is needed to confirm or rule out the disease.

## **TYPES OF CASES**

- **Laboratory Case.**

- Refers to an individual classified as having a particular disease or condition based primarily on the results of laboratory testing.
- Timing of the test in relation to symptom onset is important.
- Plays a crucial role in disease surveillance, outbreak investigations, and research.
- Examples:- HIV, Tuberculosis, Influenza, COVID-19, etc

## TOOLS TO MEASURE DISEASE FREQUENCY

- Count
- Proportion
- Ratio
- Rate
- Incidence
- Prevalence

Note:- All functions of numerators (cases) and denominator  
(population at risk or those at risk but disease free)



## COUNT

- **Simplest and most frequently performed quantitative measure**
- **Refers to the number of cases of disease or other health related phenomenon**
- **Occurrence of a single or a few cases regardless of the size of the population at risk**
- **Enough to initiate a public health response**

# PROPORTION

➤ A proportion is a fraction in which the numerator is a part of the denominator

➤ Usually expressed as a percentage

$$\frac{\text{Number of Students with Jaundice}}{\text{Total Number of Students}}$$

# RATIO

- A Ratio is a fraction in which there may be no specified relation between the numerator and denominator
- **Examples**
  - ✓ Ratio between number of males who had jaundice and number of females who had jaundice
  - ✓ **Doctor – Population Ratio**
  - ✓ Sex Ratio

## RATE

- **Rate** is number of cases occurring during a specific period;
- Dependent on the size of the population during that period
- **Calculated to determine the frequency of disease which includes:-**
  - ✓ **The number of cases of the illness**
  - ✓ **The size of the population at risk**
  - ✓ **The period during which the rate is calculated**

$$\text{Rate \%} = \frac{\text{Number of Cases}}{\text{Population at Risk}} \times 100$$

# **MORTALITY MEASURES**

- **Crude Death Rates**
- **Specific Death Rates**
- **Case Fatality Ratio**
- **Proportional Mortality Ratio**
- **Survival Rate**

## CRUDE DEATH RATE

- Number of deaths in one year per 1000 estimated mid year population in a given place
- **Summarizes**
  - ✓ Age composition of the population
  - ✓ **Age specific death rates**
  - ✓ Lacks Comparability
  - ✓ **Able to portray mortality in a single figure**
  - ✓ Useful in demography

## **SPECIFIC DEATH RATES**

### **➤ Cause or Disease Specific**

- ✓ Tuberculosis
- ✓ Cancer
- ✓ Accidents

### **➤ Group Specific**

- ✓ Age
- ✓ Gender

## **CASE FATALITY RATIO (CFR)**

- **Total number of Deaths due to a particular disease x 100**  
**Total number of Cases of the disease**
- **Represents the killing power of the disease**
- **Typically used in acute infectious diseases**
- **Is closely related to virulence**
- **May change because of changes in the:-**
  - ✓ **Agent**
  - ✓ **Host**
  - ✓ **Environment**



# PROPORTIONAL MORTALITY RATIO

## ➤ For a Specific Disease

Number of deaths due to a specific disease x 100

Total number of deaths from all causes

- ✓ Infectious diseases / Vaccine preventable diseases
- ✓ Non Communicable diseases

## ➤ For a Specific Group

Number of deaths below five years of age x 100

Total number of deaths

- ✓ Population groups
- ✓ Different periods of time

## SURVIVAL RATE

- Is the proportion of survivors among a group of patients followed up over a period of time
- **Used as a yardstick for assessment of therapy**
- Used specifically in malignancies

$$\frac{\text{Total number of patients alive after 5 years}}{\text{Total number of patients of the disease}} \times 100$$

## **MEASURES OF MORBIDITY**

- **Describes the magnitude and characteristics of the disease load**
- **Clinically more relevant than mortality data**
- **Essential for research on disease etiology**
- **Useful for prioritizing and monitoring health care activities**
- **Incidence**
  - ✓ **Attack Rate**
  - ✓ **Secondary Attack Rate**
- **Prevalence**
  - ✓ **Point**
  - ✓ **Period**

# INCIDENCE

- **Number of new cases of a disease**
  - ✓ **In a given population**
  - ✓ **Over a specified period of time**
- **Describes the rate of development of disease**
- **Components**
  - ✓ **Numerator: Number of new cases**
  - ✓ **Denominator: Population at risk**
  - ✓ **Time: Period during which the cases accrue**
  - ✓ **Multiplier**

## **SPECIAL INCIDENCE RATES**

### ➤ **Attack Rate**

- ✓ An incidence rate
- ✓ Result of a specific exposure
- ✓ Population observed for a short period of time
- ✓ Expressed as a percentage

### ➤ **Secondary Attack Rate**

- ✓ **Percentage of exposed persons who develop the disease within the incubation period following exposure to a primary case**

$$\frac{\text{Number of exposed persons developing disease within the incubation period}}{\text{Total number of exposed susceptible contacts}} \times 100$$

## **SPECIAL INCIDENCE RATES**

### **➤ Secondary Attack Rate**

- ✓ Applied to infectious diseases where the primary case is infective for a short period of time**
- ✓ Susceptibles need to be clearly identified**
- ✓ Difficult to calculate in diseases with a large proportion of sub – clinical cases**
- ✓ Useful in evaluating effectiveness of control measures**
- ✓ Isolation**
- ✓ Vaccination**

# PREVALENCE

- **Prevalence of a disease or condition in a population is defined as:**
  - ✓ **The total number of cases (existing cases) of the disease in the population at a given time**
  - or**
  - ✓ **The total number of cases in the population, divided by the number of individuals in the population**
- **It is a proportion usually expressed as a percentage**

## PREVALENCE AND INCIDENCE

➤ Prevalence is a function of incidence and duration of an illness

➤  $P = ID$

➤  $I = P/D$

➤  $D = P/I$

➤ P- Prevalence, I – Incidence , D - Duration



# **INCIDENCE VS PREVALENCE**

## **➤ Incidence**

- ✓ Research into aetiology of disease**
- ✓ Initiating control measures**
- ✓ Checking efficacy of preventive or therapeutic measures**

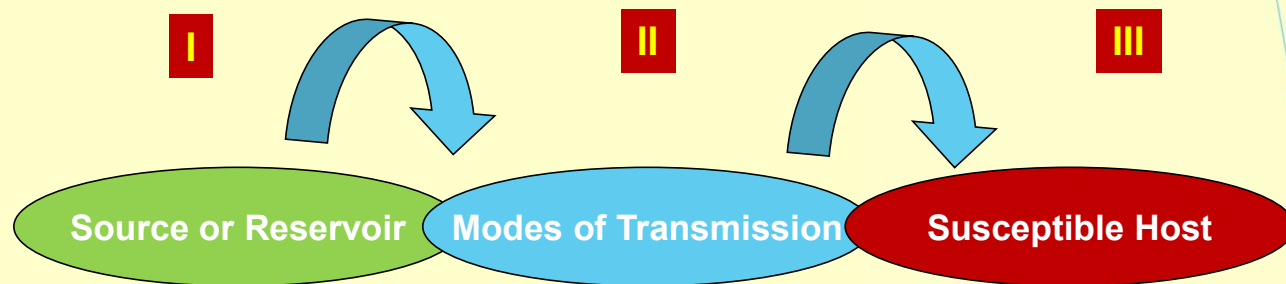
## **➤ Prevalence**

- ✓ Useful for administrative and planning purposes**
- ✓ Estimate the magnitude of disease in the community**

## **REPRODUCTIVE RATE OF INFECTION**

- Potential for an infectious disease to spread.
- **Factors include**
  - ✓ Probability of transmission between an infected and a susceptible individual
  - ✓ **Frequency of population contact**
  - ✓ Duration of infection
  - ✓ **Virulence of the organism**
  - ✓ Immunity of the population

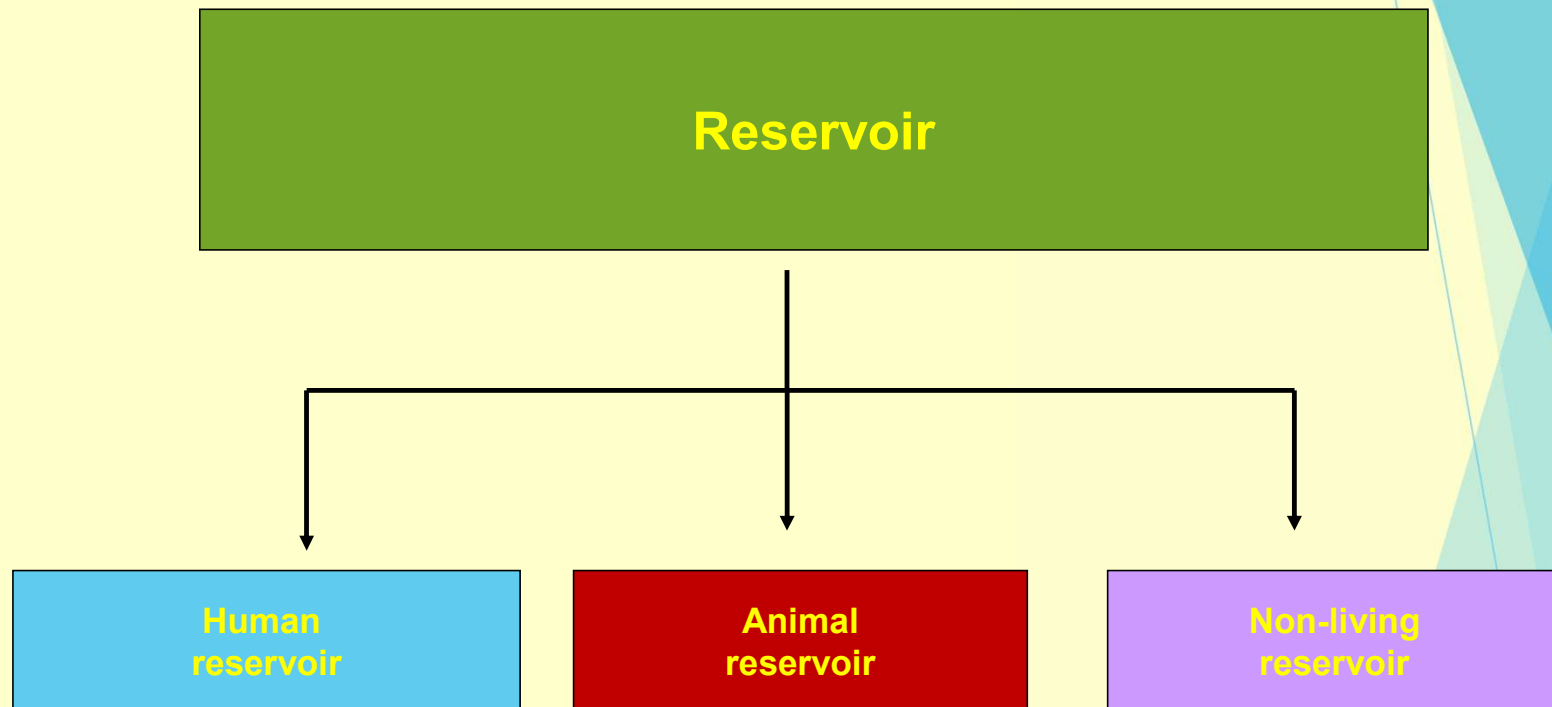
# DYNAMICS OF DISEASE TRANSMISSION: CHAIN OF INFECTION



## **ELEMENTS OF AN EPIDEMIOLOGICAL TRIAD**

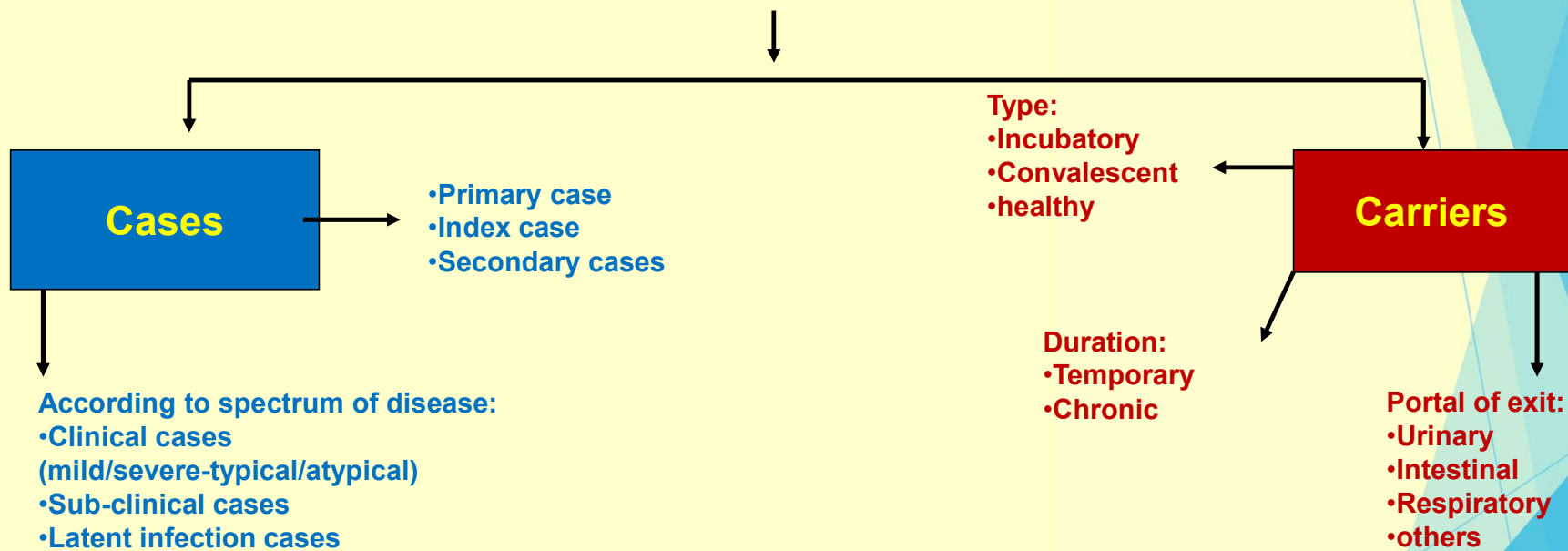
- **Host.** Lodgment to an infectious agent under natural conditions
- **Types of Hosts**
  - ✓ Obligate host,
  - ✓ **Definitive (primary) host**
  - ✓ Intermediate host
  - ✓ **Transport host**
- **Reservoir.**
  - ✓ **Person, animal, arthropod, plant, soil, substance, or combination of these**
  - ✓ **Infectious agent lives and multiplies**
  - ✓ **Depends primarily for survival, and reproduces itself in such a manner that it can be transmitted to a susceptible host**
  - ✓ **Natural habitat of the infectious agent.**
- **Agent / Vector.**
  - ✓ **Any living carrier that transports an infectious agent from an infected individual or its wastes to a susceptible individual or its food or immediate surroundings**
  - ✓ **Both biological and mechanical transmissions are encountered**

# TYPES OF RESERVOIRS



# HUMAN RESERVOIR

## Human Reservoir



## **CARRIERS**

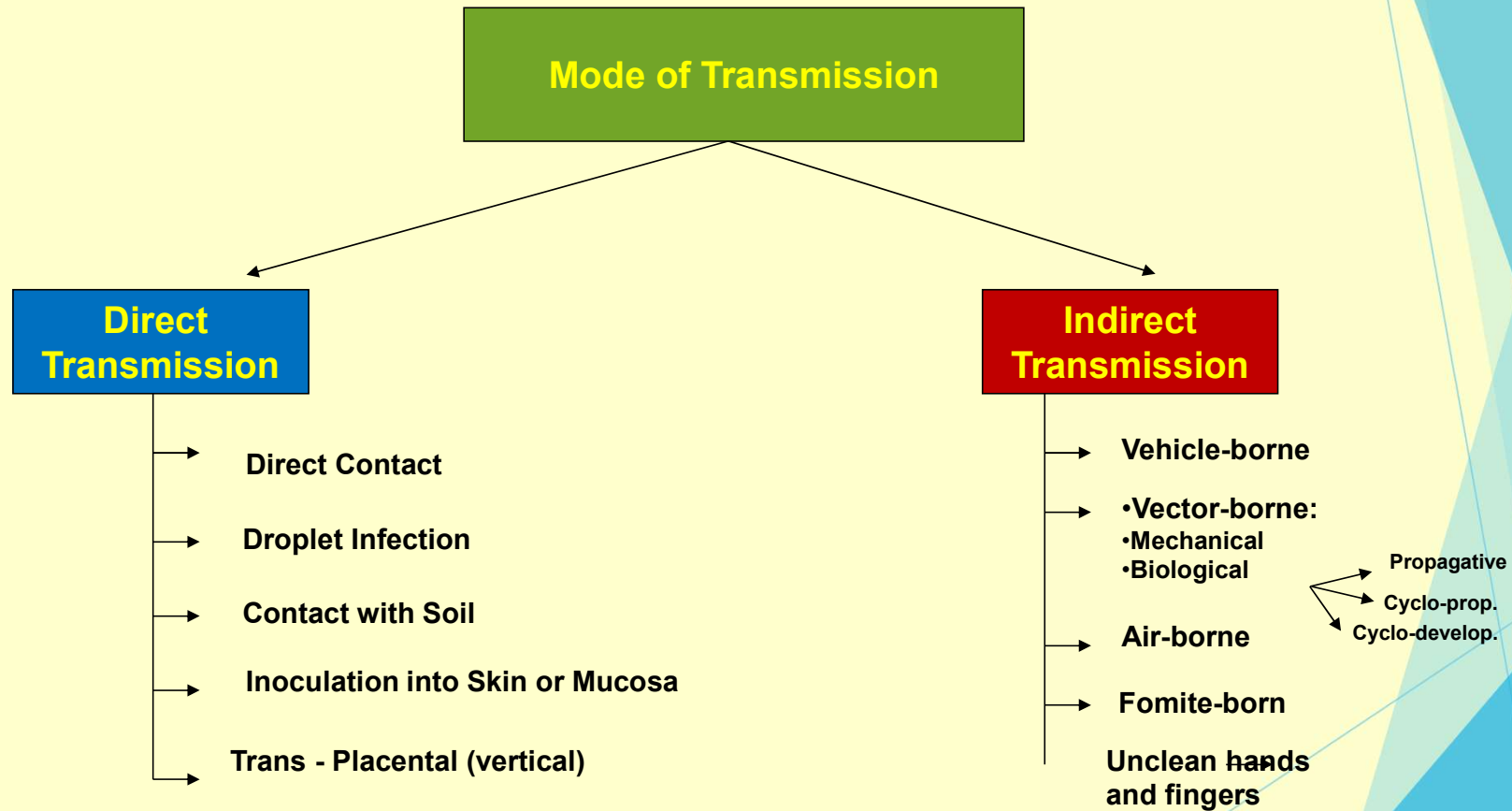
- **Either due to inadequate treatment or immune response, the disease agent is not completely eliminated, leading to a carrier state.**
- **It is an infected person or animal that harbors a specific infectious agent in the absence of visible clinical disease and serves as a potential source of infection to others.**
- **Three essential elements of a carrier state:**
  - ✓ **Presence of disease agent.**
  - ✓ **Absence of recognizable symptoms and signs of disease.**
  - ✓ **Shedding of the virus / bacterial in the discharge / excretions.**

## **ANIMAL RESERVOIRS**

- **Zoonosis.** Is an infection transmitted from animals to man, e.g. rabies, plague, bovine tuberculosis, etc
- **Reservoir in Non-living Things.**
  - ✓ Soil and inanimate matter can also act as reservoir of infection.
  - ✓ E.g. Tetanus, Anthrax, etc



# MODES OF TRANSMISSION



## **SUSCEPTIBLE HOST**

- **An infectious agent seeks a susceptible host.**
- **Four stages are required for successful parasitism:**
  - ✓ **Portal of entry**
  - ✓ **Site of election inside the body**
  - ✓ **Portal of exit**
  - ✓ **Survival in external environment**

## VIRULENCE AND CASE FATALITY RATE

### ➤ Virulence.

- ✓ Degree of pathogenicity; the disease evoking power of a micro-organism in a given host.
- ✓ Numerically expressed as the ratio of number of cases of overt infection to total number infected, as determined by immunoassay.

### ➤ Case Fatality Rate for Infectious Diseases.

- ✓ It is the proportion of infected individuals who die of the infection.
- ✓ It is a function of severity of the infection and is heavily influenced by un-diagnosed mild cases.

## **SERIAL INTERVAL AND INFECTIOUS PERIOD**

### ➤ **Serial interval:**

- ✓ **The interval between onset of the primary and the secondary cases.**
- ✓ **The interval between receipt of infection and maximal infectivity of the host (also called generation time).**

### ➤ **Infectious (communicable) Period:**

- ✓ **Length of time a person can transmit disease.**

# INCUBATION AND LATENT PERIODS

## ➤ Incubation Period:

- ✓ Time from exposure to development of disease (first sign or symptom of the disease).

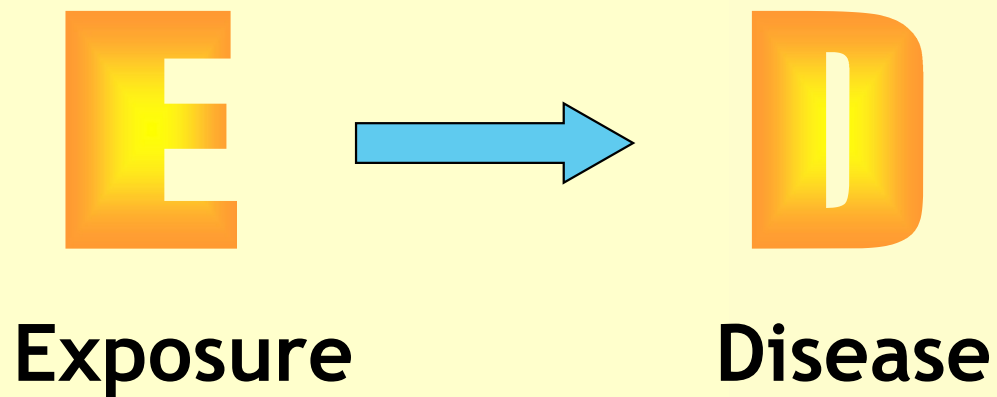
## ➤ Latent period:

- ✓ The period between exposure and onset of infectiousness (may be shorter or longer than the incubation period).
- ✓ E.g. Herpes Zoster

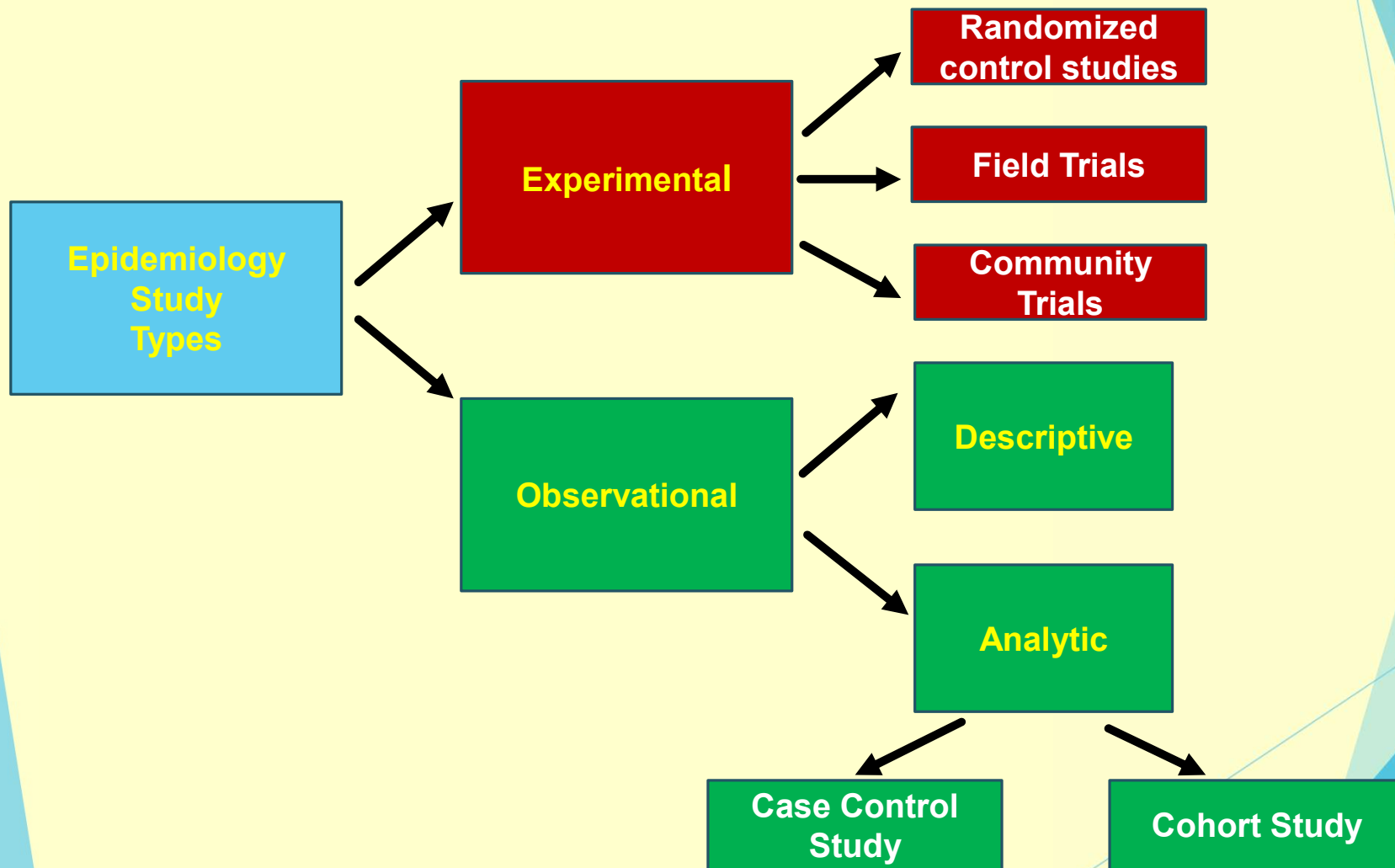
## TRANSMISSION PROBABILITY RATIO (TPR)

- TPR is a measure of risk transmission from infected to susceptible individuals during a contact.
- Types of Transmission Probabilities.
  - ✓ p00: tp from unvaccinated infective to unvaccinated susceptible
  - ✓ p01: tp from vaccinated infective to unvaccinated susceptible
  - ✓ p10: tp from unvaccinated infective to vaccinated susceptible
  - ✓ p11: tp from vaccinated infective to vaccinated susceptible

# ARE EXPOSURE AND DISEASE LINKED?



# EPIDEMIOLOGY STUDY TYPES





## **DESCRIPTIVE STUDIES: STEPS**

- **Step #1: Defining the Population.**
- **Step #2: Defining Disease under Study.**
- **Step #3: Describing the Disease - Time, Place, Person.**
- **Step #4: Measurement of Disease - Mortality/ Morbidity.**
- **Step #5: Compare - Between different Population, Subgroups.**
- **Step #6: Formulate Hypothesis.**

## **CROSS-SECTIONAL STUDIES: PREVALENCE**

- **Simplest form of observational study.**
- **Based on single examination of cross-section of population at one point of time.**
- **Results can be projected to the entire population.**
- **Useful for chronic illnesses, e.g. hypertension.**
- **Save on time and resources,**
- **Provides minimum information about natural history of disease and incidence of illness.**

## CASE CONTROL STUDIES

- The study proceeds backwards from effect to cause
- Both exposure and outcome have occurred before start of the study

# RISK FACTORS & RISK GROUPS

## ➤ Risk Factors

- ✓ An attribute or exposure significantly associated with development of disease
- ✓ A determinant that can be modified by intervention, reducing the possibility of occurrence of disease / outcome.

## ✓ Risk Groups

- ✓ Directly proportionate to needs.
- ✓ Used to prevent disease by removal or minimizing the risk.

## ODDS RATIO

- It is a measure of strength of association between the risk factor and outcome.
- The derivation of the odds ratio is based on three assumptions:-
  - ✓ The disease being investigated is relatively rare
  - ✓ The cases must be representative of those with the disease
  - ✓ The controls must be representative of those without the disease

## ODDS RATIO

- ▶ A 2×2 table is constructed, displaying exposed cases (A), exposed controls (B), unexposed cases (C) and unexposed controls (D).

	CASE	CONTROLS
EXPOSED	A	B
UNEXPOSED	C	D

- ▶ To measure association is the odds ratio (OR), which is the ratio of the odds of exposure in the cases (A/C) to the odds of exposure in the controls (B/D), i.e.

$$OR = (AD/BC).$$

## ODDS RATIO

Category	Case with lung cancer	Control without lung cancer
<b>Smokers</b> (less than 5 )	<b>33 (a)</b>	<b>55 (b)</b>
<b>Non-Smokers</b> (less than 5 )	<b>2 (c)</b>	<b>27 (d)</b>

### 1. Exposure rates among cases

$$=a/(a+c) = 33/35 =94.2\%$$

### 2. Exposure rate among the controls

$$=b/(b+d) = 55/82 =67\%$$

$$\text{Odds ratio} = a \times d / b \times c$$

$$33 \times 27 / 55 \times 2 = 8.1$$

- People who smoke less than 5 cigarettes per day showed a risk of having lung cancer 8.1 times higher as compared to non-smokers.

## ODDS RATIO

- ▶ OR is  $> 1$ - "those with the disease are more likely to have been exposed,"
- ▶ OR close to 1 then the exposure and disease are not likely associated.
- ▶ OR  $< 1$ -exposure is a protective factor in the causation of the disease.



## **REFERENCES**

- **A Short Introduction to Epidemiology (Neal Pearce):**  
<http://csm.lshtm.ac.uk/files/2010/09/A-Short-Introduction-to-Epidemiology-Second-Edition.pdf>
- **Principles of Epidemiology in Public Health Practice, Third Edition (CDC Course)**
- **Online:** <http://www.cdc.gov/ophss/csels/dsepd/ss1978/>
- **PDF:**  
<http://www.cdc.gov/ophss/csels/dsepd/SS1978/SS1978.pdf>

# DISCUSSION

