

# Concepts of Disease Occurrence

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# How does disease occur?

- You may think that this is a very simple question.

# Contents

- History
- Germ theory of causation
- Epidemiological triad
- Rothman's pie
- Multifactorial causation
- Web of Causation

# Disease causation - History

- Supernatural theory of disease
  - Anger of God
  - Punishment by God
  - Curse by other people
  - Invasion by evil spirit.

# Germ theory of causation

- In 1860 Louis Pasteur demonstrated presence of bacteria in air.
- In 1873 he proposed the germ theory of disease.
- 1877 Robert Koch demonstrated that Anthrax was caused by a bacteria.
- But germ theory did not explain everything
  - Presence of germs did not always cause disease.
  - All diseases were not caused by germs.


# Modern Medicine

- An important concept of Epidemiology is that disease does **NOT** occur randomly in the population.
- Disease occurs in those individuals who are exposed to certain risk factors/or who are vulnerable.
- One of the important functions of Epidemiology is to find the cause of disease.

# Concepts of disease causation

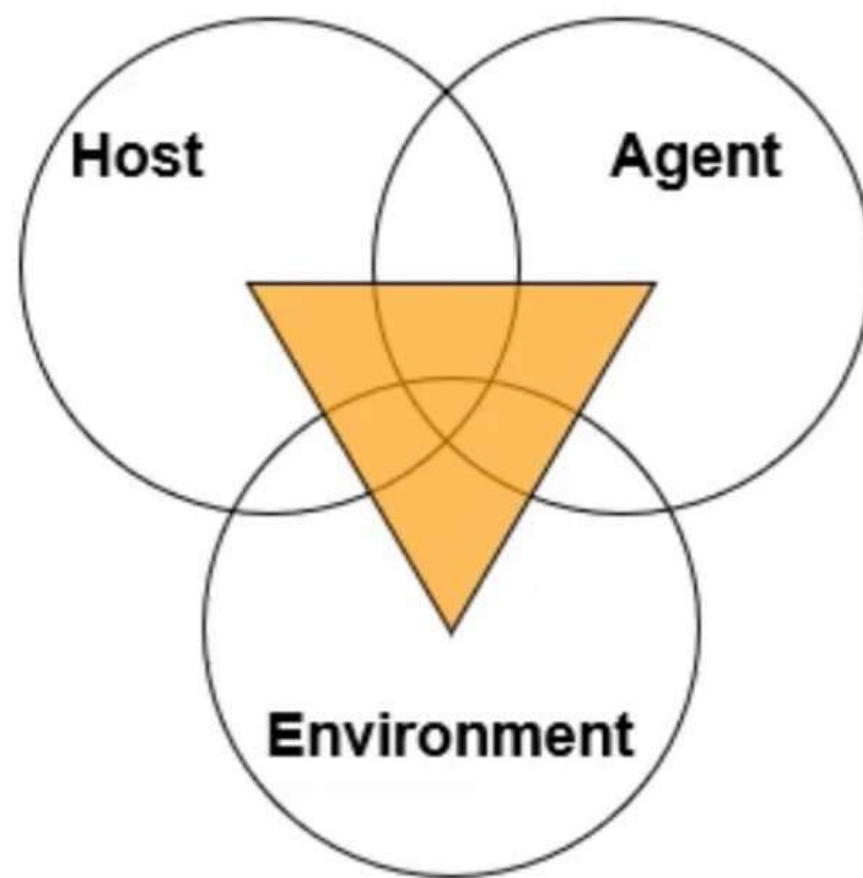
- Epidemiological triad.
- Rothman's Pie.
- Multifactorial causation.
- Web of causation.

# Epidemiological triad

- Agent
- Host
- Environment
- 
- Disease is caused by the interaction of all three factors.




# Epidemiological triad



# Agent factors

- Virus, Bacteria, stress, vitamin etc.
  - Virulence.
  - Ability to cause disease depends on the number or amount of agent.

# Host factors

- Age.
- Sex.
- Immunity. 
- Socioeconomic – overcrowding, educational status etc.
- Heredity.
- Nutritional status.
- Presence of other diseases.

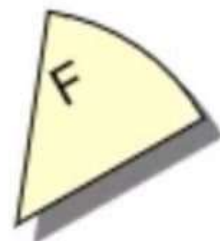
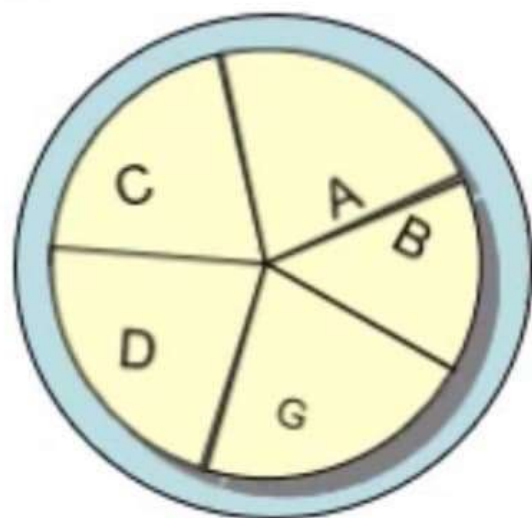
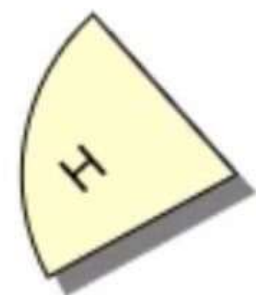
# Environmental factors

- Climate – temp, humidity etc.
- Presence of vectors.
- Sanitation.
- Availability of health services.

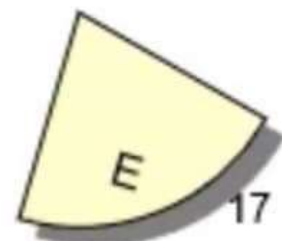


# Rothman's Causal Pies

- In case of non-communicable diseases like Cardiovascular disease, Diabetes, Hypertension etc.
- There are many risk factors.
- All of them need not be present.
- The Epidemiological triad does not explain the causation satisfactorily.



**Rothman's causal pies**



# Rothman's Causal Pie

- Not all risk factors are necessary to cause disease.
- When the required number of risk factors joins it is called Sufficient cause.
- If some risk factor is present always, it is called Necessary cause.
- Disease prevention can be achieved even by blocking just **ONE** risk factor!

# Multifactorial causation

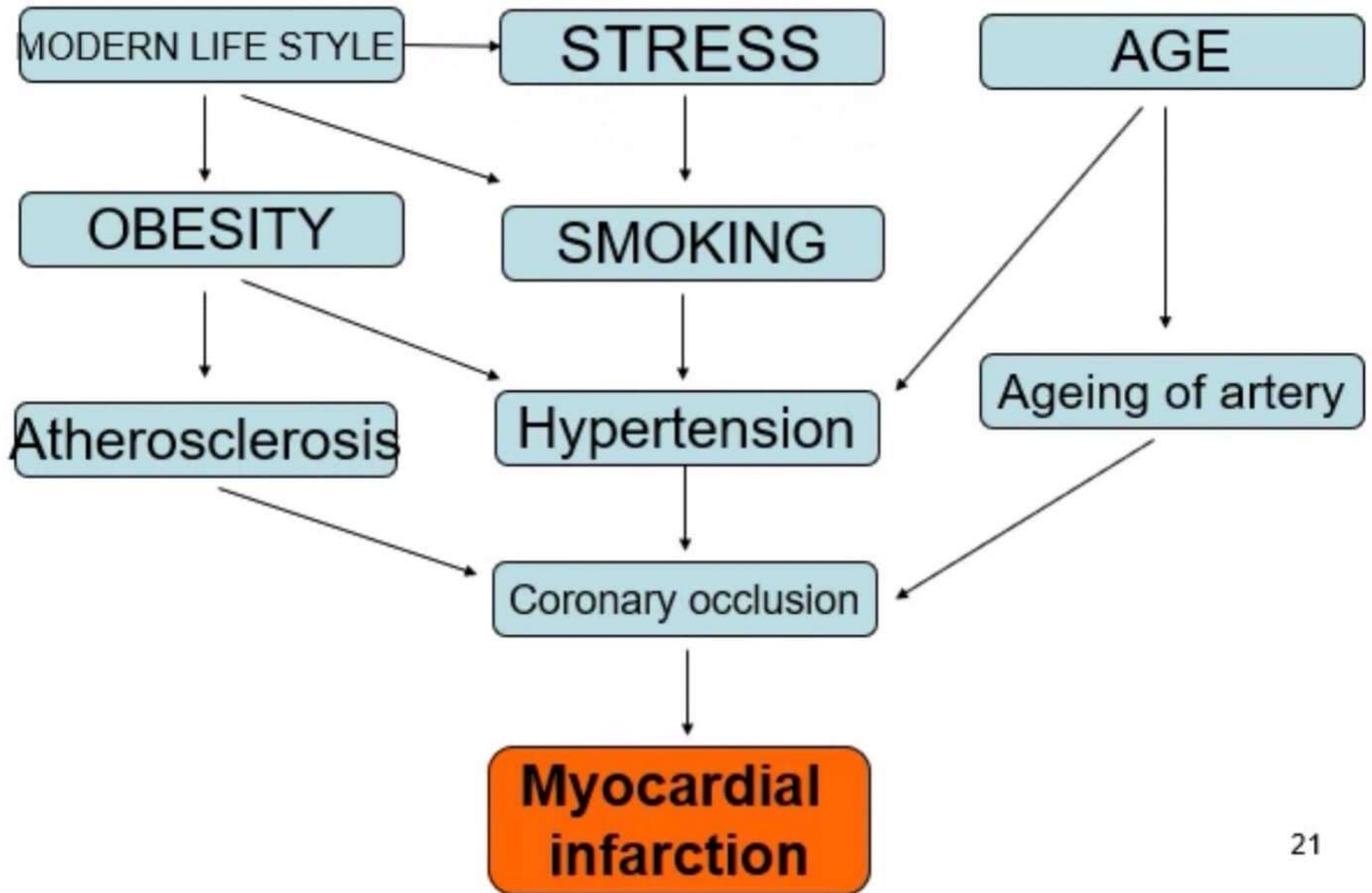
- Suggested by Pettenkofer of Munich.
- Tuberculosis is not caused by presence of *Mycobacterium tuberculosis* alone.
- Contributing factors like overcrowding, malnutrition etc. needs to be present.
- Coronary heart disease – excess fat intake, smoking, lack of physical exercise, obesity etc.



# Web of causation

- Mac Mohan and Pugh.
- Web of causation considers all predisposing factors or risk factors and their interaction.

# Web of causation for Myocardial Infarction



# Investigation of an Outbreak

## **Definition of Outbreak/Epidemic**

- Outbreak is occurrence of disease/or any health-related event in a community in excess of expected level is called an Outbreak/epidemic.

# Examples

- Outbreak of Cholera in Zimbabwe 2008.
- A Massachusetts college closes down after over 100 students fall ill with norovirus infections – March 2009.
- Outbreak of Salmonellosis in USA – peanut butter is the source of infection 2008.
- Outbreak of SARS in China 2001.

## Investigation of outbreak (Epidemic)

- Investigating an outbreak is an important duty of Medical Officer/Doctors responsible for Public Health.
- They have to follow a systematic and scientific approach to find the cause of the outbreak and control the outbreak and prevent morbidity and mortality.

# What is excess?

- It depends on the disease and the community.
- If it is a serious disease with high mortality even a small increase will be considered as an outbreak.
- If it is a mild disease only a big rise in incidence will be considered as outbreak.

# What is an outbreak?

- Will one case of Polio in Palestine be an outbreak?
- Yes, because the expected number of Polio cases in Palestine is Zero!
- But in Nigeria and India more than 600 or 700 cases of Polio will be considered as an outbreak.

# What is an outbreak?

- There are 100 cases of Cutaneous Leishmaniasis every month in a city.
- Will 110 cases of Leishmaniasis be outbreak?
- May be yes/ may be no, because the disease is not very serious.
- Will 150 cases of Leishmaniasis be an outbreak?



# What is an outbreak?

- Definitely yes.
- There are 2 cases of Rabies in a city every month.
- Will 5 cases of rabies be an outbreak?
- Yes, because even though 5 is small number the disease causes death.
- So we should consider it as an outbreak.

# Outbreak versus Epidemic

- Both words have the same meaning.
- Usually a small Epidemic is called Outbreak.
- We normally use the word Outbreak to prevent fear among the public.
- People will become worried if they hear there is an Epidemic so we use the term Outbreak.

# Steps in investigating an outbreak

- Verification of diagnosis.
- Confirmation of the existence of an outbreak.
- Identification of cases and their characteristics.
- Study of the ecological factors.
- Further investigation of population at risk.
- Data analysis.
- Formulation of hypothesis.
- Recommendation for prevention or control.

# Steps in investigating an outbreak

## Step 1 Verification of diagnosis

- The first step is to confirm the diagnosis.
- Sometimes people report that there is an outbreak but the diagnosis may be wrong.
- E.g. Some body may report outbreak of Smallpox, but the real diagnosis will Chickenpox.

# Steps in investigating an outbreak

## Step 2 Confirmation of outbreak

- Next is to confirm that there is an Outbreak.
- Newspaper may report that there is an outbreak without knowing the real expected incidence of the disease in the area.

# Steps in investigating an outbreak

## Step 2 Confirmation of outbreak

- When they see a few cases around their house they may think that there is an outbreak.
- So first check the records to see the actual incidence and make sure that there is an incidence more than the expected to confirm an outbreak.

# Steps in investigating an outbreak

## Step 3 Identification of cases and their characteristics

- Identify all the cases in the outbreak and obtain all relevant information about the cases to identify source of outbreak.
- Information about cases should be obtained from hospitals, laboratory etc.

# Steps in investigating an outbreak

## Step 3 Identification of cases and their characteristics

- Information about the exposure to risk factors should be obtained. E.g. in outbreak of typhoid information on source of food/water intake should be obtained.



# Steps in investigating an outbreak

## Step 4 Study of ecological factors

- The ecological factors which may have made the outbreak possible should also be investigated.
- Change in temperature, movement of people, changes in the vector (e.g. mosquito), changes in animal reservoir etc.

# Steps in investigating an outbreak

## Step 4 Study of ecological factors

- E.g. An increase in the mosquitoes may be responsible for an outbreak of Malaria.

# Steps in investigating an outbreak

## Step 5 Further investigations population at risk

- Sometimes it may be necessary to obtain additional information of the population at risk like immune status, blood examination etc.

# Steps in investigating an outbreak

## Step 6 Data analysis

- The cases are described in Time, Place and Person.
- This Descriptive epidemiology will help us know about the outbreak in detail.

# Steps in investigating an outbreak

## Step 7 Formulation of Hypothesis

- When we do the Descriptive epidemiology we will get some idea about the cause and spread of the outbreak.
- Based on that we can formulate an hypothesis on the cause of outbreak.

# Steps in investigating an outbreak

## Step 8 Recommendations for prevention and control

- The aim of investigating an outbreak is to control the outbreak and prevent future outbreaks.
- Once we know the cause outbreak and spread we can make recommendations to control/stop the outbreak.

# Steps in investigating an outbreak

## Step 8 Recommendations for prevention and control

- We can also give recommendation to prevent outbreak in future.

# Steps in investigating an outbreak

- Steps in Investigating Foodborne Outbreaks
- A foodborne outbreak investigation goes through several steps. They are described here in order, but in reality investigations are dynamic and several steps may happen at the same time.



# Steps in investigating an outbreak

1. Detecting a Possible Outbreak
2. Defining and Finding Cases
3. Generating Hypotheses about Likely Sources
4. Testing the Hypotheses
5. Finding the Point of Contamination
6. Controlling an Outbreak
7. Deciding an Outbreak is Over

# Steps in investigating an outbreak

## Steps in an OUTBREAK INVESTIGATION

**DETECT** A possible outbreak



**FIND** Cases in an outbreak



**GENERATE** Hypotheses through interviews



*If cases continue*

# Steps in investigating an outbreak

Not finding associations ←---

**TEST** Hypotheses through analytic studies and laboratory testing



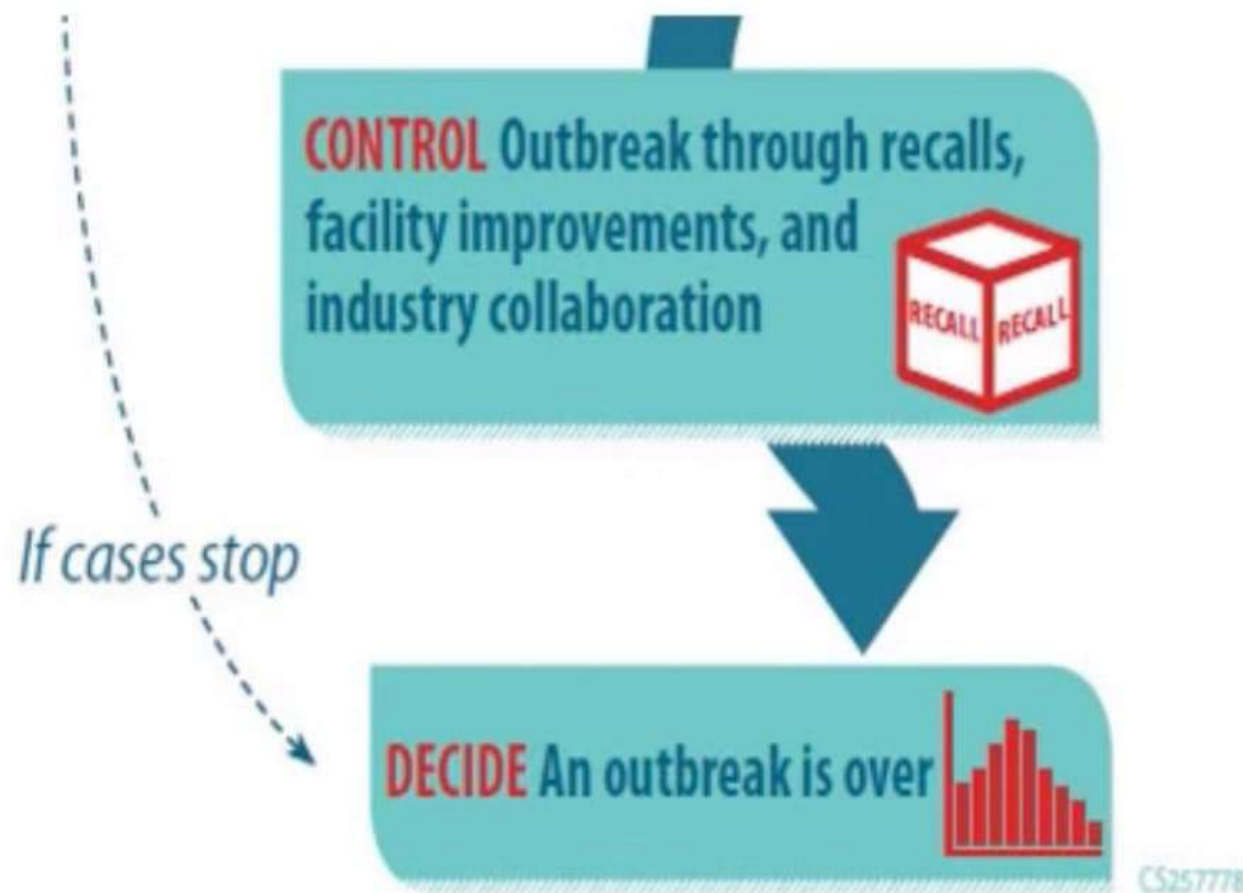
**SOLVE** Point of contamination and original source of outbreak vehicle



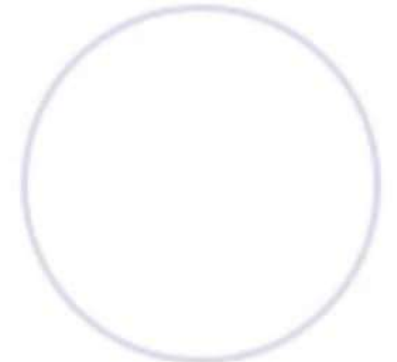
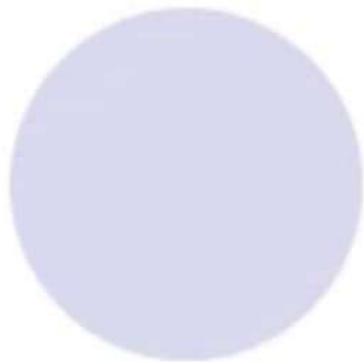
**CONTROL** Outbreak through recalls, facility improvements, and industry collaboration



# Steps in investigating an outbreak



# Concepts of Disease Control and Prevention



# Levels of Prevention

- Primordial prevention.
- Primary prevention.
- Secondary prevention.
- Tertiary prevention.

# Principles of prevention

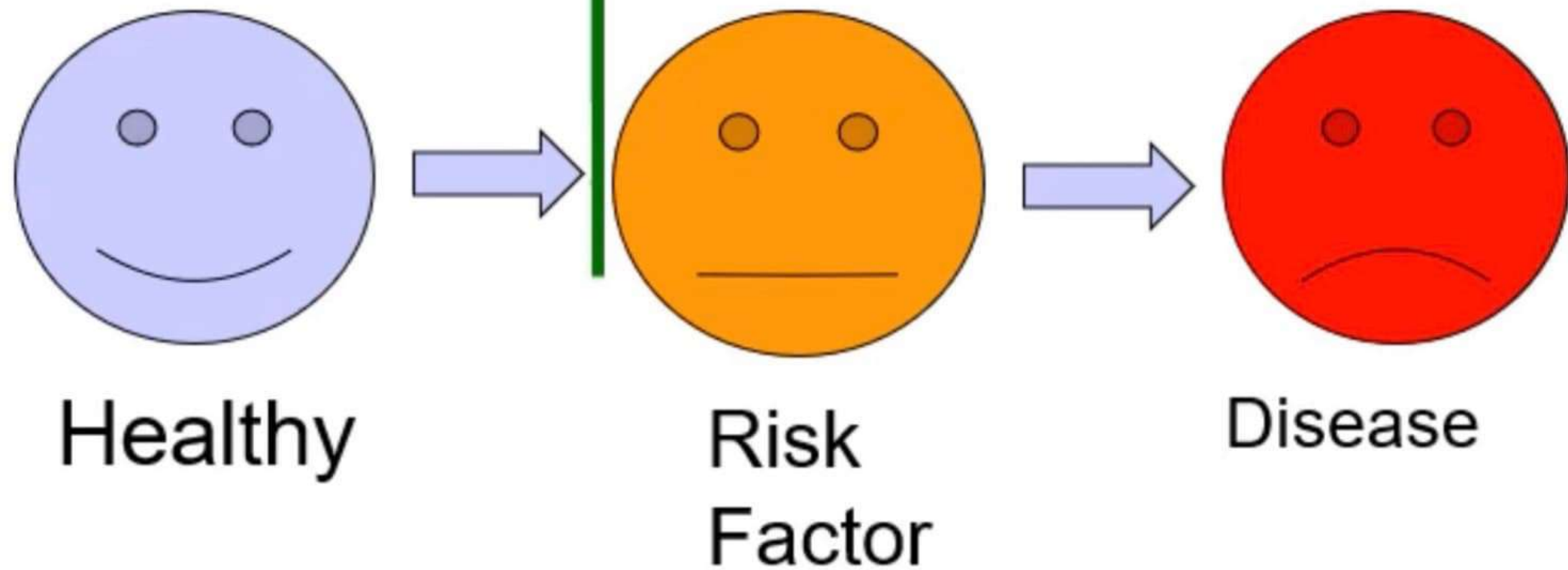
- Disease prevention and control depend on the phase in the natural history of disease.
  - Pre-pathogenic phase.
  - Pathogenic phase.

# Primordial prevention

- In Primordial prevention we prevent emergence of risk factors.
- Most useful in preventing **CHRONIC DISEASES** e.g. Diabetes Mellitus & Hypertension.
- Risk factors like Smoking, Obesity, Sedentary life style etc. are prevented.



# Primordial prevention



# Methods of Primordial prevention

- Health education
  - Individual
  - Mass (Group)

# Primary prevention



- Primary prevention is action taken before the onset of disease.

# Methods of Primary prevention

- Population (mass) strategy
  - We do the intervention to the entire population.
- High risk strategy
  - We do intervention only to people at high risk.

# Methods of primary prevention

- Population strategy
  - Rubella vaccination to all children.
  - Hepatitis B vaccination to everybody.
- High risk strategy
  - Rubella vaccination to only girls.
  - Hepatitis B vaccination to doctors, laboratory workers etc.

# Secondary prevention

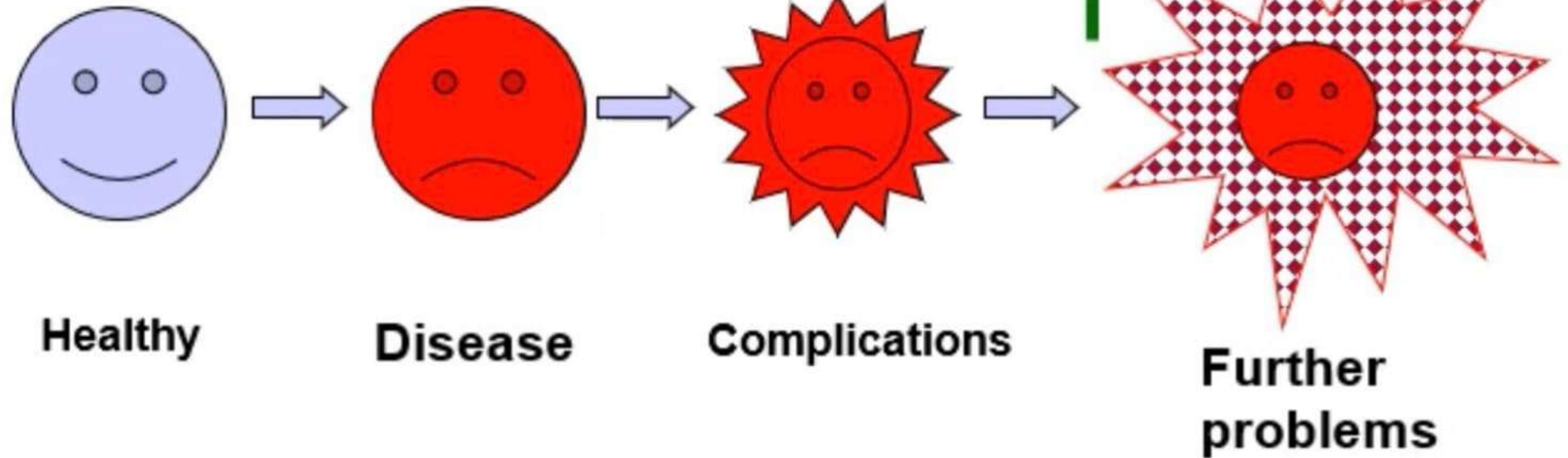
- Action is taken **AFTER** the disease has occurred to prevent complications and further injury.
- Pulmonary tuberculosis if not treated can lead to hemoptysis, pneumothorax and even death.
- Diabetes Mellitus leading to renal failure.

# Tertiary prevention



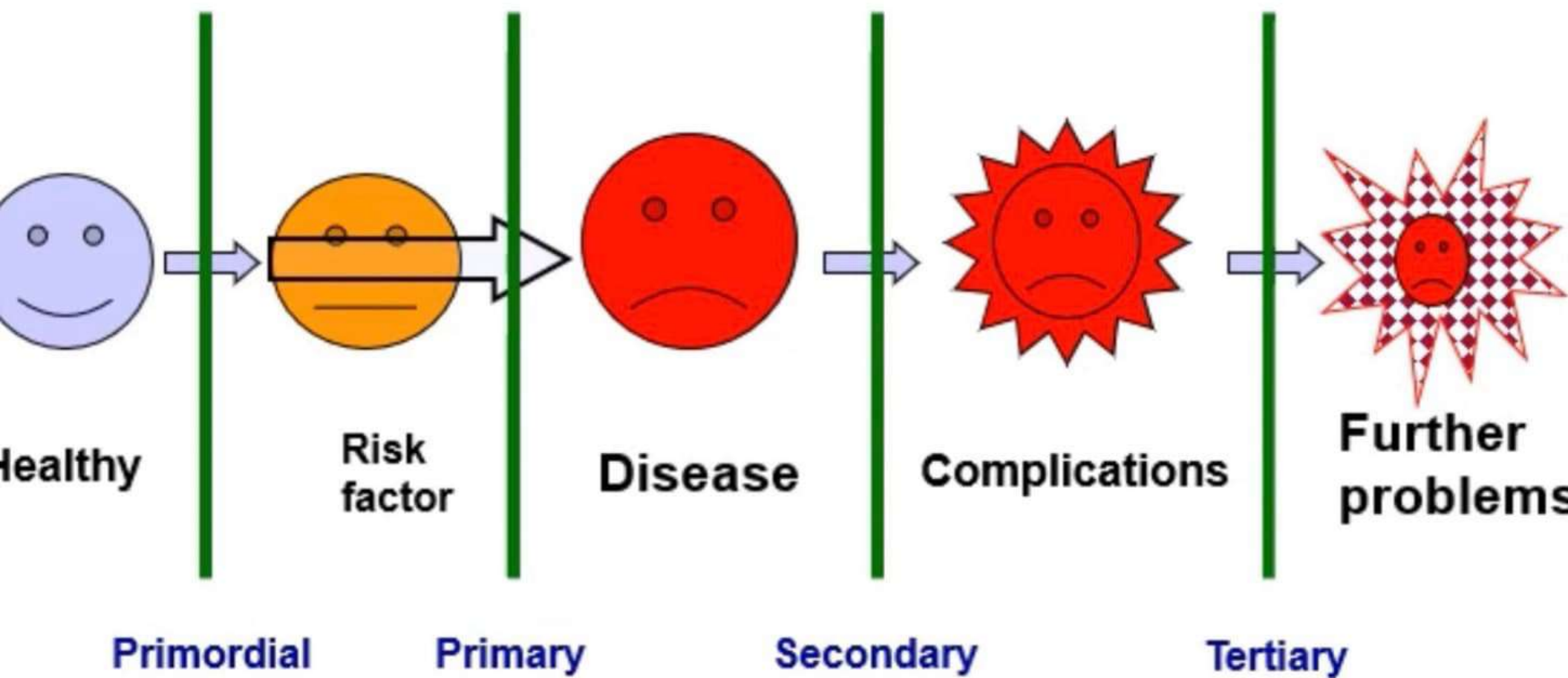
- Disease has already occurred and even complications but we try to prevent further consequences of disease.
- Paralysis due to Poliomyelitis has occurred but we try to prevent further injury due paralyzed legs.

# Tertiary prevention





# Levels of Prevention



# Modes/Methods of intervention

- Primary

- Health promotion.

- Specific protection.

- Secondary prevention

- Early diagnosis and treatment.

# Modes/Methods of intervention

- Tertiary prevention
  - Disability limitation.
  - Rehabilitation.



# Health promotion

- The goal is to improve health, make the body strong to prevent diseases.
  - Health education
    - How to prevent diseases e.g. washing hands.
  - Environmental improvement
    - Safe drinking water, prevent breeding of mosquitoes.

# Health promotion


- Nutritional intervention

- Give balanced diet.

- Lifestyle changes

- Prevent smoking, do physical exercises.

# Specific protection



- Immunization
- Chemoprophylaxis e.g. against Malaria.
- Nutrient supplementation e.g. Folic acid, Iron, Vitamin A.

# Early diagnosis and treatment

- Diagnose disease early and treat to prevent complications- e.g. Tuberculosis.
  - Screening for Diabetes Mellitus, Hypertension.
  - Mass treatment e.g. Filariasis.

# Disability limitation and Rehabilitation

- In case of paralysis due to Poliomyelitis.
- Providing crutches/calipers will prevent further injury to the leg.
- It will also help the patient to walk, work - **Rehabilitation.**



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# Crutches and calipers for children with polio paralysis



**Caliper**

**Crutches**

# Concepts in Disease Control

- Disease Control.
- Disease Elimination.
- Disease Eradication.
- Disease Surveillance.

# Disease Control

- The disease is controlled so that it is not a serious public health problem.
  - Tuberculosis is controlled in Palestine.

# Disease Elimination

- Disease is not present in some countries.
- But disease is present in other countries.
- Immunization must be done to prevent disease.

# Disease Elimination

- Disease is not present in some countries.
- But disease is present in other countries.
- Immunization must be done to prevent disease.
  - E.g. Polio is eliminated from Palestine (but present in Nigeria, India).

# Disease Eradication

- The disease is not present anywhere in the world.
- The agent is also NOT present in the world.
- So there is no need to immunize
  - Example - Smallpox

# Disease surveillance

- Surveillance is the collection of data which is analyzed to prevent disease and improve the health of community.
- AFP (acute flaccid paralysis) surveillance to detect Polio cases is necessary for Polio eradication.



# Summary



- Primordial prevention
  - Prevent developing of risk factor.
- Primary prevention
  - Prevent disease before occurring.
- Secondary prevention
  - Prevent progression of disease.
- Tertiary prevention
  - Prevent further complications/Rehabilitation.