NOTES ON:

PRINCIPLES OF VETERINARY EPIDEMIOLOGY

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DISEASES IN POPULATION

- **A DISEASE** is a particular abnormal condition that negatively affects the structure or function of part or all of an organism, and that is not due to any external injury

- **POPULATION:** A complete collection of individuals that have some particular characteristic (s) in common. It could be of known size e.g. 50 fish in aquarium or of unknown size as tick populations in infested cows or number of stray dogs in certain district.

ETIOLOGY OF DISEASES "DETERMINANTS"

DETERMINANTS:

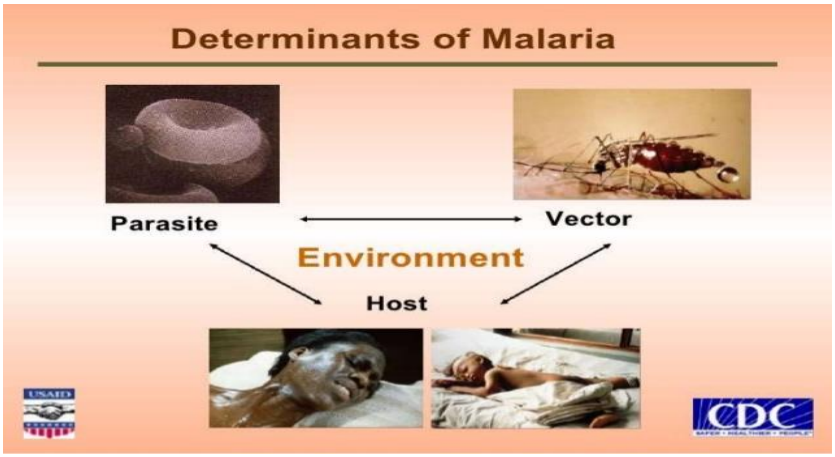
* Definition. Disease is caused by multiple factors. Those factors are determinants of disease, i.e. any characteristic that affects the health of a population.

- Epidemiologists assume that illness does not occur randomly in a population, but happens only when the right accumulation of risk factors or determinants exists in an individual.
- To search for these determinants, epidemiologists use analytic epidemiology or epidemiologic studies to provide the "Why" and "How" of such events.
- Ideally, the findings provide sufficient evidence to direct prompt and effective public health control and prevention measures.

Classification of determinants

1. Primary and secondary
2. Intrinsic and Extrinsic
3. Determinants associated with host, agent or environment

1. **Primary and secondary**: For the initiation of most diseases;
   i. **Primary determinant:** Primary cause of a disease
   ii. **Secondary determinants.** Factors responsible of spread of a disease



1-Primary determinants = factors whose variations exert a major effect in inducing disease → necessary causes

- ❖ Examples for primary determinants: viruses, bacteria, parasites, trauma, climate, radiation, allergens, mineral deficiency (also all extrinsic); genetic constitution, metabolism, behaviour (also all intrinsic)

2-Secondary determinants = predisposing, enabling and reinforcing factors → component causes

- ❖ Examples for secondary determinants: age, sex, breed, hormonal status, immunological status (also all intrinsic); location, trauma, concurrent disease, vaccination status, husbandry (also all extrinsic)

1-PRIMARY DETERMINANTS (SPECIFIC FACTOR):

A) INTRINSIC: The causal agent is an integral part of the host.

1. **Hereditary**: Due to genetics different breeds have different risks for diseases, such as Cryptorchidism in horses, and umbilical hernia in calves.
2. **Metabolic and hormonal diseases** e.g. bloat in cattle, where clover at certain stage of growth gives rise to frothy bloat, but the exact cause of fermentation is unknown.
3. **Behavioral disorders**: e.g. weaving in horses, feather pecking and cannibalism in poultry.

B) EXTRINSIC: The causal agent is not integral part of the host. Includes:-

1. **Non- living agent:** Physical agents' e.g. trauma, bite of insects, fractures,etc
2. **Chemical agents** e.g. organic and inorganic poisons, poisonous plants, allergy,etc
3. **Living agents** e.g. bacteria, viruses, Mycoplasma, rickettsia, helminthes, fungi, etc.

2-SECONDARY DETERMINANTS (PREDISPOSING FACTORS).

A) INTRINSIC: - It includes:-

1. **Age:** is very important because the risk of many diseases changes widely over the animal's life due to underlying physiological changes that are associated with age, Neonates are highly susceptible to many enteric and respiratory infections but resistance increases as the animals mature.
2. **Sex.** This has a relative susceptibility of different sexual organs and tissues on invasion by pathogenic agents, as infection of pregnant uterus of the cows by B.abortus
3. **Species breed and strain**. There is a natural variation in the susceptibility of animals to diseases e.g. FMD can affect cattle and sheep while horses are resistant.

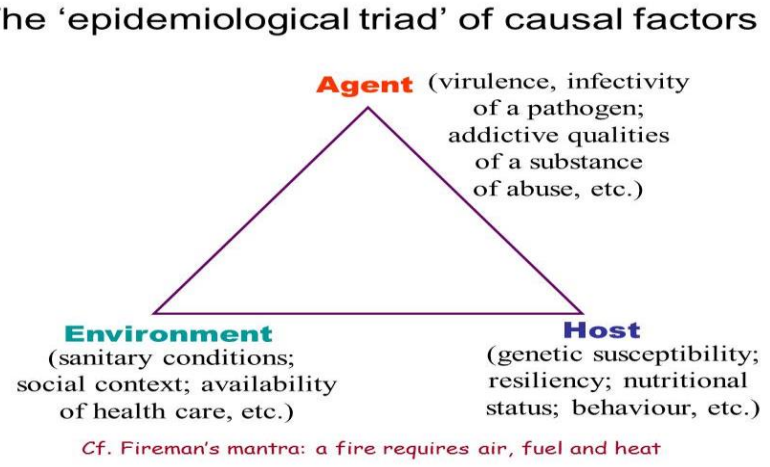
4. **Metabolism and hormonal balance**. There are effects of sex hormones, cortisone and metabolic state on the disease condition on the other hand, estrogen cause relative resistance of the uterus to vibrio and trichmonas infection during estrus.
5. **State of nutrition**.Well-nourished animals is more resistant to the disease than those which are underfed e.g. Helminthes and john's disease. Also, good condition and highly fed animals are susceptible to some diseases than in poor condition e.g. enterotoxaemia diseases.
6. **Stress.** Stress factors have a great role in the spreading of diseases e.g., parasitic infestation, increases the incidence of hepatic necrosis (black disease) in lambs.
7. **Physiological state**. Brucellosis is established only after puberty causing abortion at the 6th months of pregnancy or later.
8. **Vaccination .**increases an individual's resistance to disease but the protection is not absolute for most biologics.

B-EXTRINSIC: It includes the factors in the environment

1) Animal stocking density, animal movement between groups; Housing (e.g. ventilation, sanitation):
2) Environmental conditions (e.g. temperature, humidity, wind velocity, precipitation).

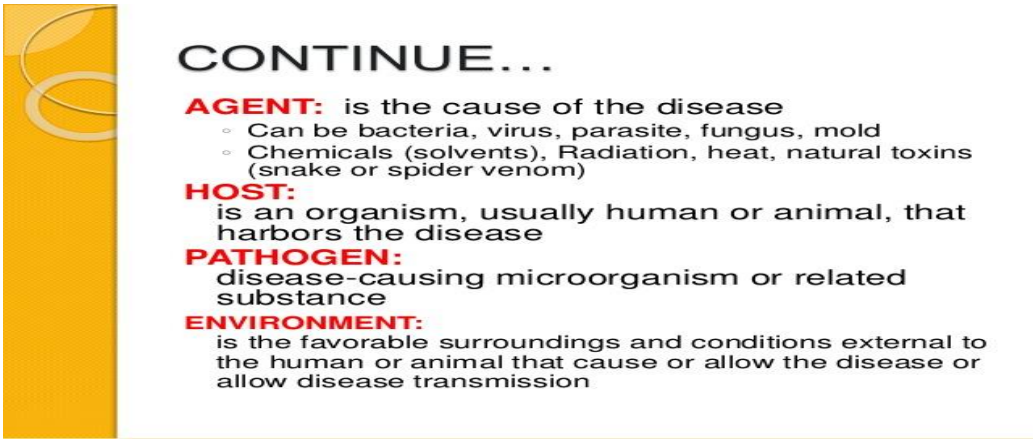
I) EPIDEMIOLOGICAL TRIAD "DETERMINANTS ASSOCIATED WITH HOST, AGENT OR ENVIRONMENT "

Definition: A model used to explain the etiology "cause" of diseases.



* **Animal disease results** from interaction between the host, agent and the environment. A vector may be involved in transmission.

* **A vector, an organism** which transmits infection by conveying the pathogen from one host to another without causing disease itself, may be part of the infectious process.



1-AGENT: Biological, physical, or chemical factors whose presence, absence are necessary for the disease to occur. Examples: bacteria, viruses, fungi, poison, drugs, trauma, radiation, fire.

AGENT FACTORS: A variety of factors influence whether exposure to an organism will result in disease, including the

1. **INFECTIVITY** .The capacity of an agent to produce infection or disease. Measured by the secondary attack rate.
2. **PATHOGENICITY** .The capacity of the agent to cause disease in the infected host. Measured by the proportion of individuals with clinically apparent disease.
3. **VIRULENCE** .Refers to the severity of the disease. Measured by the proportion of severe or fatal cases. If fatal, use case fatality rate.

2- HOST is an organism, usually human or animal, that harbors the disease

HOST FACTORS (INTRINSIC) A variety of factors intrinsic to the host, called risk factors, can influence an individual's exposure, susceptibility or response to a causative agent. It includes:-

1. Genetics "Breed" 2- Innate resistance (e.g. gastric barrier)
2. Previous exposure 4- Vaccination status and response
3. Age , sex , bread ,etc
4. Behavior (e.g. mutual grooming, dominance, pica)
5. Production status (e.g., lactating vs. non-lactating)
6. Reproductive status (e.g., pregnant vs. non-pregnant)

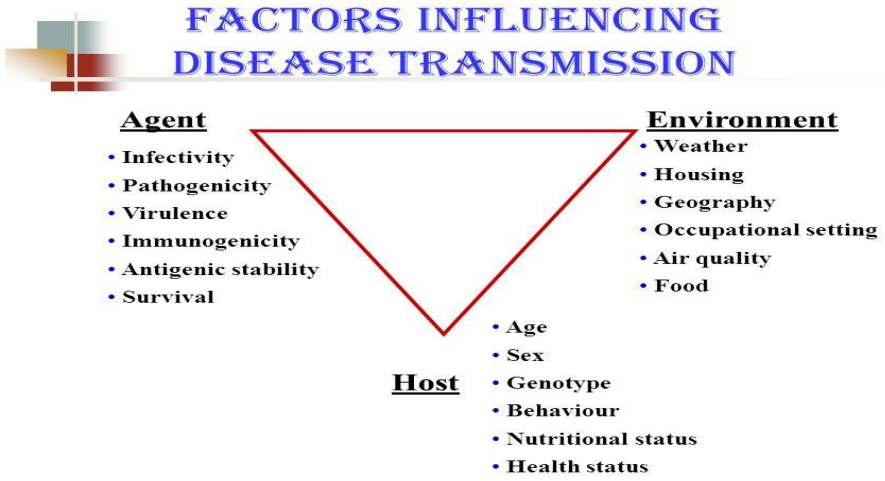
3) **THE ENVIRONMENT** is the favorable surroundings and conditions external to the human or animal that cause or allow the disease or allow disease transmission

- Environmental factors can include the biological aspects as well as the social, cultural, and physical aspects of the environment

Table (1): Factors associated with the increase risk of animal diseases.

Host Characteristics	Agent	Environmental Factors
Age	Infectivity	Stocking density/Herd size
Sex	Pathogenicity	Regions, , herds, Animal movement ,climatic changes, feeding etc
Production statuas	Virulence	Geographical distribution
Genetics		Environmental conditions/hygiene
Previous Disease		Housing
Immune Status		Climate/climatic changes
Vaccination status		Nutritional status
Body confirmation		Air, water , feed pollution

Factors associated with occurrence of diseases or outbreaks



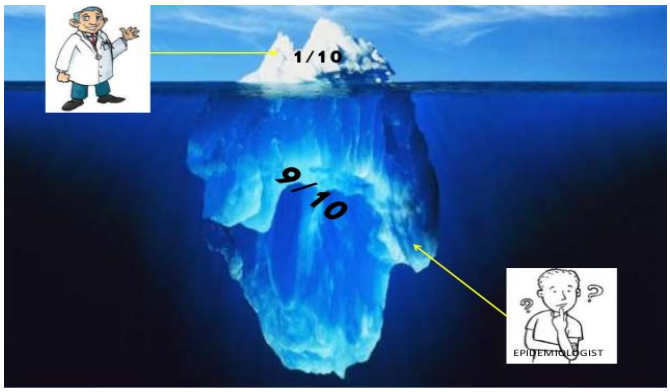
NATURAL HISTORY AND SPECTRUM OF DISEASE

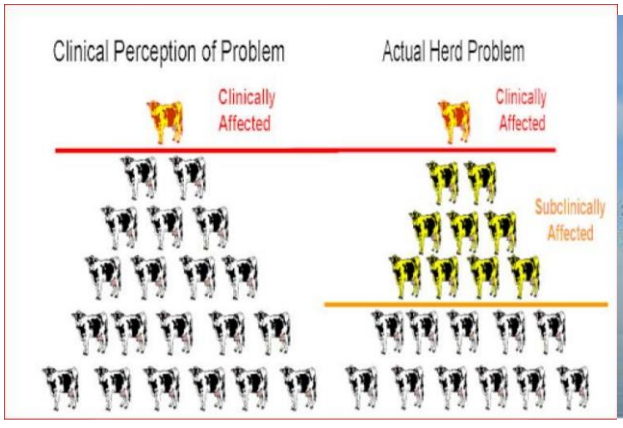
- The "natural history of disease" refers to the progression of disease process in an individual over time; in the absence of intervention.
- There are four stages in the natural history of a disease. These are:
  1. Stage of susceptibility
  2. Stage of pre-symptomatic (sub-clinical) disease
  3. Stage of clinical disease
  4. Stage of recovery, disability or death

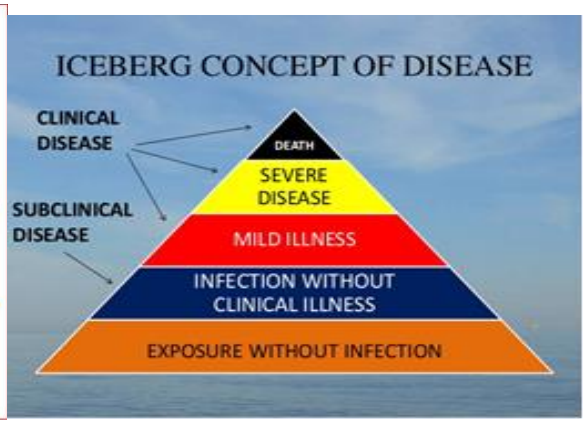
- The process begins with the appropriate exposure to or accumulation of factors sufficient for the disease process to begin in a susceptible host. For an infectious disease, the exposure is a microorganism.
- For cancer, the exposure may be a factor that initiates the process, such as asbestos fibers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

ICEBERG PHENOMENON OF DISEASES

* **Iceberg phenomenon of disease** gives a picture of the spectrum of diseases in a community.
* **The visible part of the iceberg** denotes the clinically apparent cases of disease in the community. The part of the iceberg below the water level denoted the latent, subclinical, undiagnosed and carrier states in the community, which forms the major part.
* **The hidden part is** especially important in disease like hypertension, diabetes and malnutrition.
* **Some diseases exhibiting iceberg phenomenon:** diabetes , hypertension ,malnutrition, mastitis ,TB ,parasitic infestation





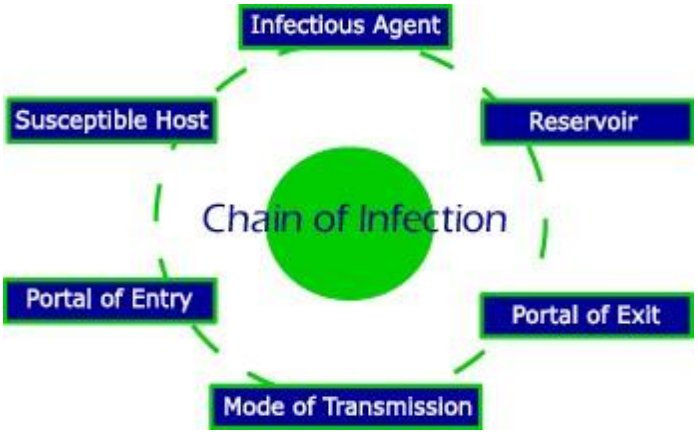


CHAIN OF INFECTION

DEFINITION. The six components involved in the transmission of microorganisms are illustrated and described as the chain of infection.

THE 6 ELEMENTS OF THE CHAIN ARE:

1. **Infectious Agent** - e.g. virus, bacteria, protozoa, fungi, animals (worms)
2. **Reservoir -** Where the agent normally resides
3. **Portal of Exit** - How the agent leaves the host
4. **Mode of transmission** - Direct or indirect contact
5. **Portal of Entry** - How the agent enters the susceptible host
6. **Susceptible Host** - Impacted by overall health, genetic factors, etc.



All these six components should be present to transmit an infectious disease from one human or animal to a susceptible host.

1. CAUSATIVE AGENT

- **The causative agent** for infection is any microorganism capable to producing disease.
- **Microorganisms** responsible for infectious diseases include bacteria, viruses, fungi, and protozoa. Sometimes, microorganisms are part of patient's own body flora and can cause infection in the immunocompromised host. These infections are called endogenous infections. Infections which are acquired from external sources are called exogenous infections

2. RESERVOIR OR SOURCE

a) **RESERVOIR** is the 2nd link in the chain of infection.
   - A reservoir is the place where the agent survives, grows, and/or multiplies: human, animal or environment. • e.g. Pseudomonas spp. survive and multiply . It is the natural habitat of the infectious agent."

b) **THE SOURCE** is defined as "the person, animal, object or substance from which an infectious agent passes or is disseminated to the host (immediate source).

c) **A CARRIER** is a person who is colonized with a specific pathogenic microorganism but shows no signs or symptoms of infection, e.g. salmonella and Avian flu in water fowl

THE ELEMENTS IN A CARRIER STATE ARE:

1. The presence of the disease agent in the body.
2. The absence of recognizable signs and symptoms of disease.
3. The shedding of the disease agent in the discharges or excretions thus acting as source of infection for others

CARRIERS MAY BE CLASSIFIED AS BELOW:

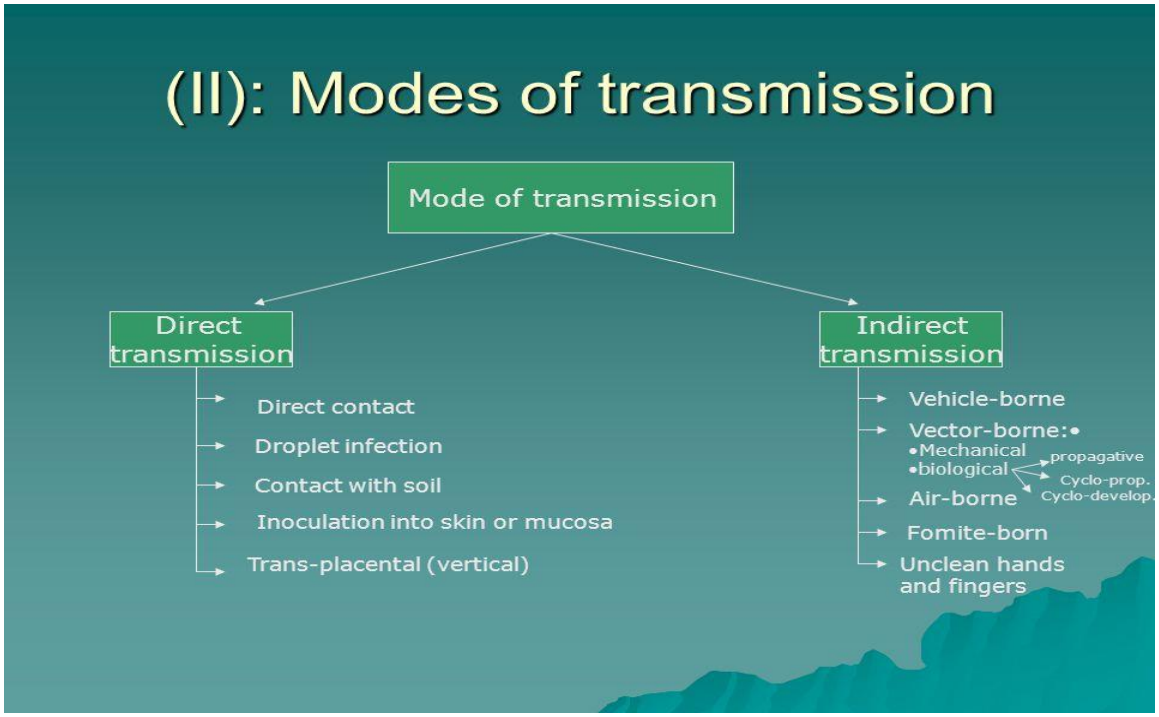
- **A. Type**
  1. **Incubatory** carriers are those who shed the infectious agent during the incubation period of the disease.
  2. **Convalescent** carriers are those who continue to shed the disease agent during the period of convalescence
  3. **Healthy** carriers emerge from the subclinical cases. They are the victim of subclinical infection who has developed carrier state without suffering overt disease.

- **B. Duration**
  3. **Temporary carriers**: Are those who shed infectious agent for short periods of time.
  4. **Chronic carriers**: A carrier who excretes the infectious agent for indefinite period.

5. PORTAL OF EXIT

- The portal of exit is the path by which an infectious agent leaves its reservoir. Usually, • this portal is the site where the microorganism grows. Common portals of exit include the respiratory, genitourinary, and gastrointestinal tracts, the skin and mucous membranes and the placenta (transmission from mother to fetus).

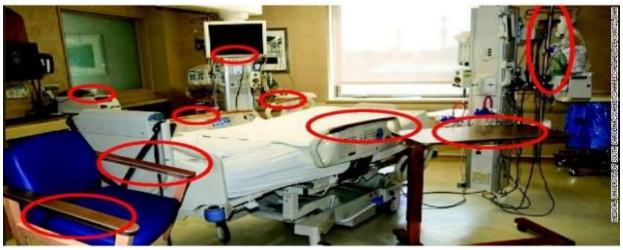
MODE OF DISEASE TRANSMISSION



4. Mode of transmission

- **Direct contact: it** refers to person-to-person spread of microorganisms through actual physical contact.

- **Indirect contact:** occurs when a susceptible person comes in contact with a contaminated object.
  - In health care settings, virtually any item could be contaminated with certain microorganisms, e.g. endoscopes, respiratory equipment, etc. Thorough cleaning, disinfection, and sterilization are essential in the health care.



1-DIRECT TRANSMISSION

* It is the transfer of an infectious agent directly into the body. It occurs through direct contact with the pathogen, but the pathogen can be delivered into the body in different ways.

There are four types of contact transmission.

* **Direct**—requires physical contact between hosts.
* **Indirect**—contact with body fluids or tissues of an infected individual.
* **Droplet**—large infectious particles sprayed into the air from the respiratory tract of an infected individual.
* **Droplet nuclei**—small infective particles that are suspended in the air, taken in by a host, and are capable of traveling to the lung.

Note: Pathogens delivered by droplet or droplet nuclei are usually limited to about one meter's distance away from the victim. Longer distances or a more

indirect route to the victim is classified as an indirect transmission through airborne means.
Examples of diseases spread by contact are sexually transmitted diseases (STDs), pink eye, Ebola, ringworm, and respiratory diseases.

2-INDIRECT TRANSMISSION

Indirect transmission is the transfer of a pathogen by a vector, vehicle, or through the air

A) BY VECTORS. A vector is a living organism, such as an insect or arthropod that carries a disease-causing agent from one host to another in the life cycle of a pathogen.

B) VEHICLE-BORNE TRANSMISSION

- Vehicle-borne transmission occurs when a non-living object carries a disease-causing agent from one host to another in the life cycle of a pathogen. Inanimate objects that can carry disease include cooking utensils, bedding, clothing, toys, surgical instruments, medical supplies, water, blood, serum, plasma, and body tissues and organs.
- Examples of diseases spread through vehicle-borne transmission are food-borne diseases and waterborne diseases.

C) AIRBORNE TRANSMISSION

* In airborne transmission, pathogens are suspended in the air and enter a body through the respiratory tract.
* This may sound at first like the droplet or droplet nuclei of contact transmission mentioned above, but in airborne transmission, infectious agents may be suspended in the air for longer periods of time.
* Pathogens become airborne when they are shed from feces, sprayed from urine, or distributed by many different processes such as heating, cooling, or venting systems, or slaughterhouse environments.

5-PORTALS OF ENTRY.

- 1) Skin 2- Gastrointestinal Tract 3- Respiratory 4-Urogenital
- 5) Via Placenta 6)Parenteral (injection, bite)

6- SUSCEPTIBLE HOST

- The final link in the chain of infection is the susceptible host.
- A susceptible host is an animal who can become infected by the infectious agent.

THERE ARE SEVERAL LEVELS OF INFECTION

- Colonization - Subclinical or Inapparent - Latent infection
- Manifest or clinical infection.

BASIC EPIDEMIC THEORY (EPIDEMIC CURVE)

* **EPIDEMIC CURVE :** : A graph in which the number of new cases of a disease is plotted against an interval of time to describe a specific epidemic or outbreak. . The shape of the epidemic curve may suggest what kind of outbreak is occurring.
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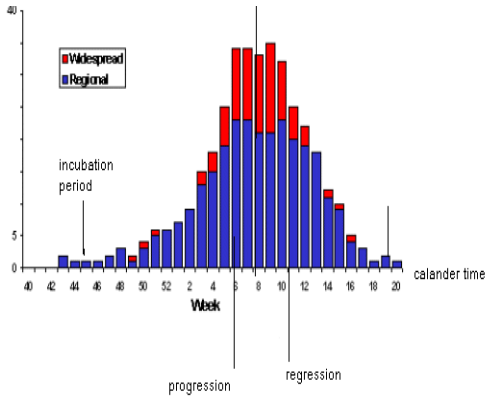
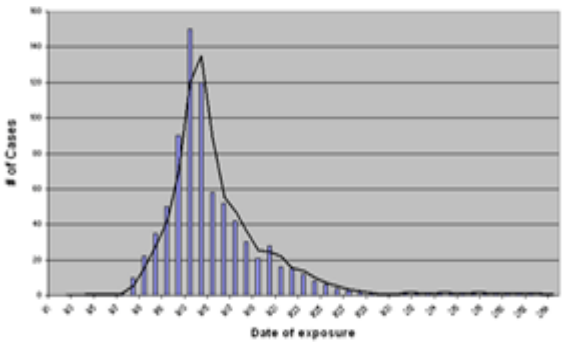
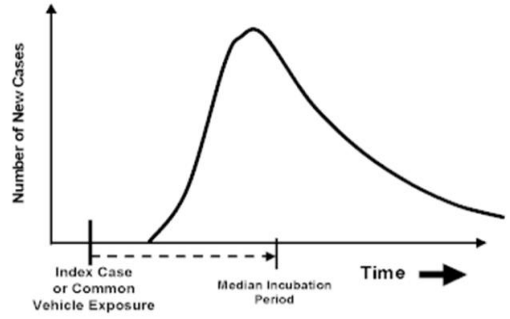




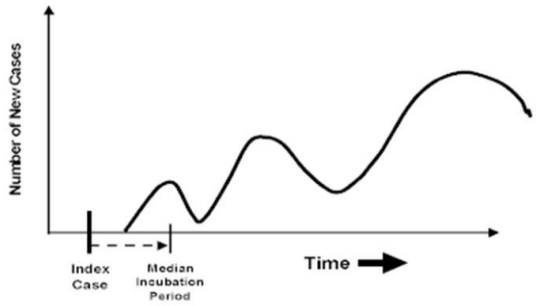
THE OVERALL SHAPE OF THE EPI-CURVE CAN REVEAL THE TYPE OF OUTBREAK

1. **POINT SOURCE EPIDEMIC**, animals are exposed to the same exposure over a limited, defined period of time usually within one incubation period.
2. **PROPAGATED (PROGRESSIVE SOURCE)** Epidemic occurs when a case of disease serves as a source of infection for subsequent cases and those subsequent cases, in turn, serve as sources for later cases

Epidemic Curve of Point Source Epidemic



Epidemic Curve of Propagating Epidemic



FACTORS AFFECTING THE SHAPE OF THE EPIDEMIC CURVE.

1. The incubation period of the disease.
2. The infectivity of the agent.
3. The proportion of susceptible animals in the population.
4. The disease between animals (i.e. animal density).

HOW CAN IT HELP IN AN OUTBREAK?

- An epi-curve can provide information on the following characteristics of an outbreak.
  1) Pattern of spread
  2) Magnitude - outliers
  3) Time trend
  4) Exposure and or disease Incubation period
- SO, a highly infectious agent with a short incubation period infecting a large proportion of susceptible animals at high density produces a curve with a steep initial slope on a relatively small time scale, representing a rapid spread of infection among the population (shift to left),
- This occurs at per-acute form of the diseases e.g. velogenic form of Newcastle and Avian influenza. Red curve

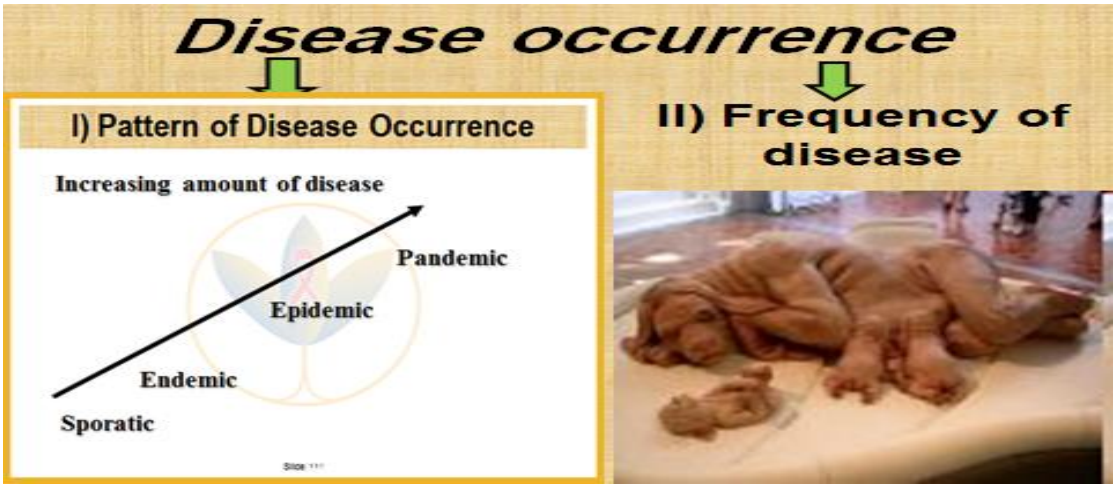
DISEASES IN POPULATION

- **Disease -** a disorder of structure or function in a human, animal, or plant, especially one that produces specific symptoms.
- **Population:** A complete collection of individuals that have some particular characteristic (s) in common . It could be of known size e.g. 50 fish in aquarium or of unknown size as tick populations in infested cows or number of stray dogs in certain district.

MEASURING OF DISEASE OCCURRENCE

I) **PATTERN OF DISEASE OCCURRENCE "QUALITATIVE "** Sporadic - Endemic – Epidemic – panademic - cyclic"

II) **FREQUENCY "QUANTITATIVE"** Prevalence, incidence, incidence rate secondary attack rate, mortality rate, case fatality rate



I) PATTERN OF DISEASE OCCURRENCE "QUALITATIVE "

1) **SPORADIC** refers to a disease that occurs infrequently and irregularly.
2) **ENDEMIC** refers to the constant presence and/or usual prevalence of a disease or infectious agent in a population within a geographic area.

Endemic diseases: The frequencies of diseases representing by:-

a. **Holo-endemic**: most population is affected.
b. **Hyper-endemic**: High proportion is affected.
c. **Meso-endemic**: moderate proportion.
d. **Hypo- endemic**: low proportion

3-EPIDEMIC refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in that area.

EPIDEMICS OCCUR 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. More specifically, an epidemic may result from:

a) A recent increase in amount or virulence of the agent,
b) The recent introduction of the agent
c) An enhanced mode of transmission so that more susceptible persons are exposed,
d) A change in the susceptibility of the host response to the agent, and/or
e) Factors that increase host exposure or involve introduction through new portals of entry.

OUTBREAK carries the same definition of epidemic, but is often used for a more limited geographic area.

EPIDEMIC PATTERNS. Epidemics can be classified according to their manner of spread through a population:

a. COMMON-SOURCE B) PROPAGATED C) MIXED

A) COMMON SOURCE EPIDEMIC – when a group of persons is exposed to a common infection or source of germs

1. **Point source** from a single source (food) .Persons exposed in one place at one time and become ill within the incubation period .Ex: bad mayonnaise at a picnic
2. **Intermittent irregular and somewhat unpredictable .** Tuberculosis spread by person to person contact and people move around and interact with other people
3. **Continuous epidemic .**When an epidemic spreads through a community or population at a high level, affecting a large number of people within the population without diminishing.

B) PROPAGATED EPIDEMIC when a single source cannot be identified, yet the epidemic or diseases continues to spread from person to person

- Usually experiences exponential growth
- Cases occur over and over longer than one incubation period.

C) MIXED EPIDEMIC . a common source epidemic is followed by person-to-person contact and the disease is spread as a propagated outbreak

4-PANDEMIC. Refers to an epidemic that has spread over several countries or continents, usually affecting a large number of people.

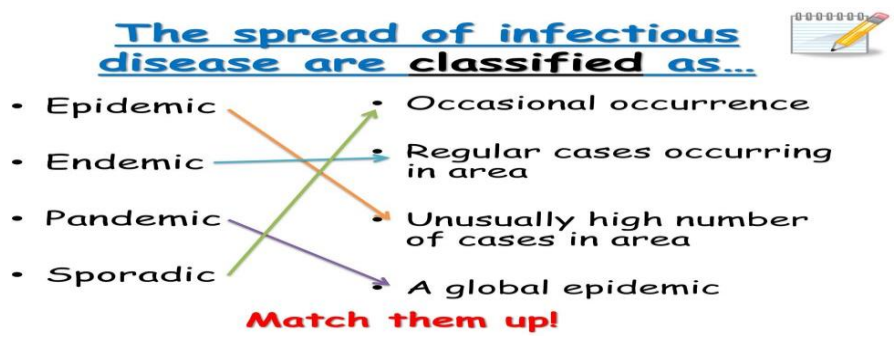
5-OTHER PATTERNS

A) DIURNAL OR SHORT TERM PATTERN : Diseases which occur during a certain period of time . e.g, during night, egg laying

B) SEASONAL PATTERN: Such as vector born diseases , poisonous plants toxicity and calf mortality .

C) CYCLIC PATTERN : It refers to the rise and wane of the disease with a fairly Constant periodicity of several years. This may be due to fluctuation in herd immunity or other known factors which be related to the agent or its reservoir. e.g., Rift valley fever)

EXERCISE "MATCH"



STRATEGIES OF MAINTENANCE"SURVIVAL" OF PATHOGENIC ORGANISMS

1. Wide host range pathogen affects different animal species .e.g., Brucellosis that makes the control of these diseases very difficult.
2. Persistence within the host: The host's defense mechanisms fail to eliminate agent.
3. Immune-suppression e.g., Bovine leukosis, virus diarrhea.
4. Antigenic variation e.g., FMD, Equine influenza ,etc.
5. Intracellular parasitism e.g., TB, Brucellosis where a pathogen is able to survive and multiply in the macrophages.
6. Avoidance of a stage in the external environment such as that occurs through Vertical transmitting e.g. Blue tongue; vector transmitting e.g. Rift valley fever
7. The development of resistance form e.g., spores in clostridia and anthrax.
8. Development of some substances: which may interfere with effect of some antibiotics on the infectious agent e.g., penicillin's enzyme.

FREQUENCY OF EPIDEMIC DISEASES

* It is the quantitative distribution of disease in a population. This can be done simply on the basis of counts the individuals which infected, diseased or dead.

1. **COUNT** : No of cases of disease : 30 cases of Kennel cough in dogs
2. **RATES :** Number of new cases / number of population (per thousand).
3. **RATIO :** Number of new cases / number of live population.
4. **PROPORTION**: Number affected/population. 30 cases in a kennel of 200 dogs; 30/200=0.15 (15%)
5. **PREVALENCE = P** "…number of diseased animals in a known population, at a designated point in time, without distinction between old and new cases."

PREVALENCE =

$$= \frac{\text{No of affected animals at a particular point in time}}{\text{Total number of animals at risk at that point in time}} \times 100$$

- **Numerator** = existing cases (old and new) with differing durations of disease
- **NOT a measure of risk** but a measure of the disease burden on the community
- A 'slice' through the population at a point in time to determine who has disease and who does not.**Does not determine when the disease developed.**

PREVALENCE =

A POINT PREVALENCE – prevalence of disease at a point in time

- "Do you currently have asthma?"

B- PERIOD PREVALENCE – prevalence of disease at a specified period of time (e.g.) a single calendar year "Have you had asthma during the last 2 years?"

* For example, if 20 cows in a herd of 200 cows were sick on a particular day, the prevalence of the sick in the herd on that day would be 20/200 that is 0.1 (10%).This is a proportion that represents the probability of an animal having a specified disease at a given time. Prevalence can take values between 0 and 1 and is dimensionless.

6) INCIDENCE (I):

* It is an expression of the number of the new cases that occurs in a known population over a period of time.
* Incidence, like prevalence, can be defined simply in terms of the number of affected animals, but is usually expressed in relation to the population at risk

CUMULATIVE INCIDENCE "CI"

- **Definition**: It is the proportion of non-diseased individuals at the beginning of a period of study that becomes diseased during such period.

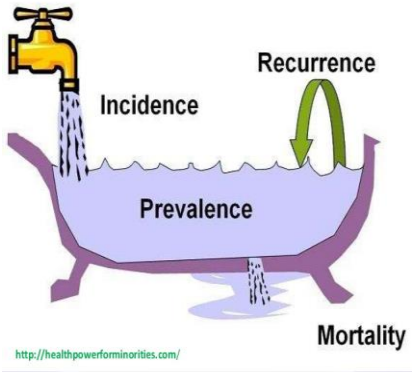
$$\textbf{CI} = \frac{\text{No of individuals become disease during particular time}}{\text{No of healthy individuals at the beginning of that period}} \times 100$$

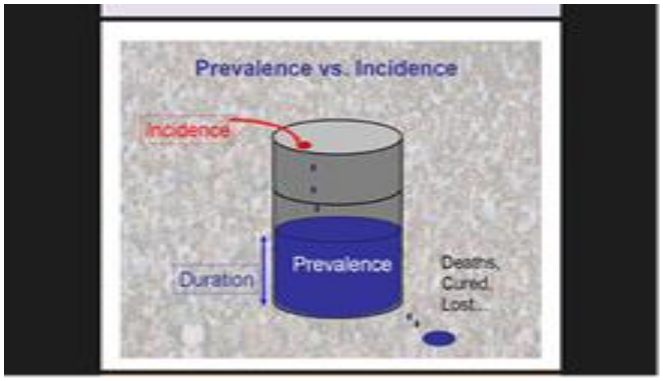
Example:

- Last year, a herd of 121 cattle were tested using the tuberculin test and all tested negative. This year, the same cattle were tested again and 25 tested positive. So, the cumulative incidence over a period of 12 months would be calculated as 25/121, which amounts to 0.21 hence, an individual animal within this herd has a 21 % chance of becoming infected.

THE RELATIONSHIP BETWEEN PREVALENCE AND INCIDENCE

- Prevalence therefore depends on the duration of the disease "D" and the incidence of the disease "I". P = I x D.
- So, decrease in the incidence of a disease such as john's disease in cattle will decrease the overall prevalence of that disease. Moreover, improvements in the therapy of diseases that are frequently fatal may decrease mortality but could increase prevalence by prolonging the life of diseased animals that otherwise would have died quickly.





7) MORTALITY RATE: Number deaths/ Total number of animals during a period of time

$$\text{Mortality rate} = \frac{\text{No of dead animals at a given period of time}}{\text{No. of population at risk at the same time}} \times 100$$

8) CASE FATALITY RATE: It is the proportion of diseased animals that die of a disease / it is therefore, a measure of the probability of death in diseased animals.

$$\textbf{Case fatality rate} = \frac{\text{No of dead animals at a given period of time}}{\text{No. of diseased animals at the same period of time}} \times 100$$

EXAMPLE OF CALCULATION OF PREVALENCE INCIDENCE MORTALITY AND CASE FATALITY RATE:-

Suppose a veterinarian investigates a disease that runs a clinical course ending in either recovery with permanent immunity or death in a herd of cattle. On 1 March, 2007, the herd was investigated when the disease is already present.

* Total herd size on 1 March, 2017 :1000
* Total number of clinically ill on 1 March, 2017 : 400
* Total number becoming clinically ill (1 March, 2007 and 1 March, 2008) :200
* Total number dying during a year : 120

* **So, prevalence** on 1 March, 2017 = (400 / 1000) x 100 = 40 %
* **C I from** 1 March, 2017 to 1 July, 2018 (200/1000) x 100 = 20%
* **Mortality rate** = (120/ 1000) x 100 = 12 %
* **Case fatality rate** = (120 / 600) x 100 = 20 %.

9) ATTACK RATE: It is the proportion of a well-defined population that develops illness over a limited period of time, e.g, during an epidemic or outbreak Attack rate is useful for comparing the risk of disease in groups with different exposures

$$\textbf{AR} = \frac{\text{Number of new cases occurring in a given time}}{\text{Population at risk at the start of the time period}} \times 100$$

Sometimes, a population may be at risk for only a limited period of time e.g., Feed contains mycotoxin). Or, due to the risk of developing the disease is limited to a narrow age-range such as the neonatal period.

DIAGNOSIS OF EPIDEMIC DISEASE

* **THE DIAGNOSIS** of any health problem depends on; the real knowledge and experience of veterinarian besides diagnostic tests which represents the basis for taking a decision when handling a health related problem.

* **SCREENING:** Is the identification of unrecognized disease by application of rapid tests to separate apparently healthy individuals which probably have the disease from those do not have the disease (The main concern is with asymptomatic healthy individuals).Theoretically, if a disease at an early stage the chances cure is good.

SCREENING TEST VERSUS DIAGNOSTIC TEST	
Screening test	Diagnostic test
1. Done on apparently healthy individuals	1. Done on sick or ill individuals
2. Applied to groups	2. Applied on single patient
3. Results are arbitrary and final	3. Diagnosis is not final
4. Based on one criteria and cut-off	4. Based on evaluation of a no. of signs/symptoms & lab findings
5. Less accurate	5. More accurate
6. Less expensive	6. More expensive
7. Not a basis for treatment	7. Used as a basis for treatment
8. Initiative comes from investigator	8. Initiative comes from a patient

A SCREENING TEST is not intended to be diagnostic. Animals with positive results should be referred for diagnosis and treatment.

* It is the basis for taking a decision when handling a health-related problem?
* Decision such as whether to treat, implement a program, e.g. mass treatment, mass immunization, selective slaughter, sanitation,etc.,.

• SCREENING VS. DIAGNOSTIC

•

- **SCREENING TESTS** aim to detect unknown disease in an well-appearing person, Test examples: temperature, CMT, Mallein,Tuberculin ,Brucellin tests
- **DIAGNOSTIC TESTS** aim to test persons who have a symptom or other evidence of potential disease. Test examples: chest x-ray, biopsy, blood/urine test.

USES OF SCREENING TEST

1. Case detection
2. Control of disease
3. For research purposes
4. Educational opportunities

INDICATION OF SCREENING TEST

Disease "burden, early detection of disease

TYPES OF SCREENING TEST

1. Mass screening
2. High risk/ selected /targeted screening
3. Multi-purpose screening, he screening of a population by more than one test done simultaneously to detect more than one disease Example: a) screening of pregnant women for VDRL, HIV, HBV by serological tests MULTIPHASIC SCREENING
4. Multiphasic screening. The screening in which various diagnostic procedures are employed during the same screening program. Example: a) DM – FBS, Glucose tolerance test b) Sickle cell anemia – CBC, Hb electrophoresis
5. Case finding screening

QUALITY OF SCREENING TESTS

Depends on:

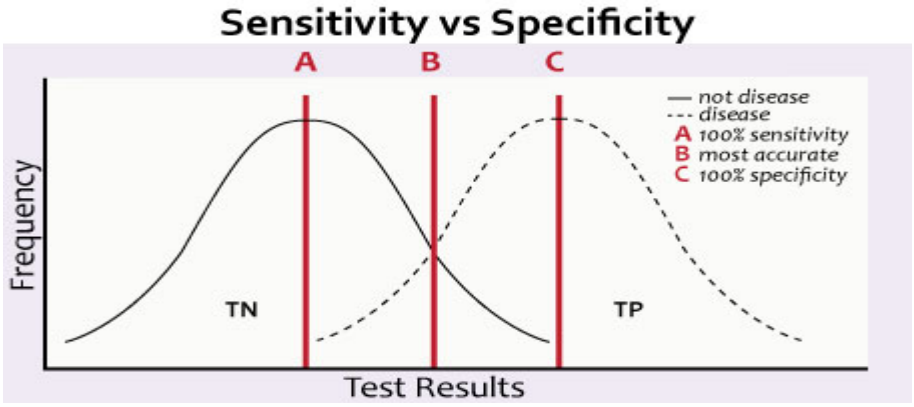
1. **Validity** : ability of the test to distinguish between who has a disease and who does not ,A perfect test would be perfectly valid
2. **Reliability: repeatability of a test .**A perfectly reproducible method of disease ascertainment would produce the same results every time it was used in the same individual.

1-VALIDITY

* **Sensitivity** – the ability of the test to identify correctly those who HAVE the disease; the search for diseased persons
* **Specificity** – the ability of the test to identify correctly those who DO NOT HAVE the disease; the search for well persons

– **SENSITIVITY AND SPECIFICITY** quantify a test's accuracy in the presence of known disease status

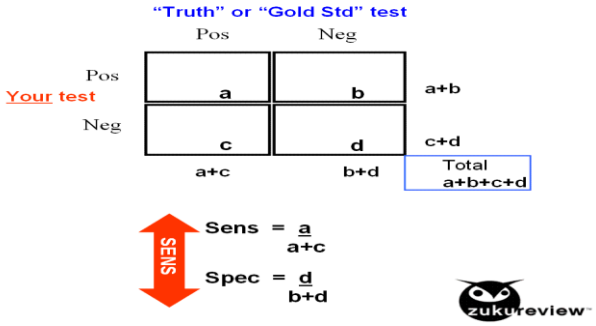
– **Note:** When calculating sensitivity or specificity, another more definitive test (gold standard) is used to know who really has or does not have the disease, e.g.) FOBT then colonoscopy w/ biopsy (the gold standard will determine true presence of ca)



2 X 2 TABLE

		DISEASE	
		+	-
TEST	+	True + (a)	False + (b)
	-	False - (c)	True - (d)
		Sensitivity = a / a + c = TP / TP + FN	Specificity = d / b + d = TN / FP + TN

The only epi table that matters: The 2 x 2



Example(1): suppose a sample of 10000 animals was tested for presence of a disease agent using a test of 96% sensitivity and 94% specificity and diseased prevalence (true)20%.

Test results	Infected	Non infected	Total
Positive	1920	480	2400
Negative	80	7520	7600
Total	2000	8000	10000

Prevalence: 20%= 20*10000/100 =2000 (infected)
10,000-2000 =8000(non infected)

Sensitivity: 96% =2000x 96/100 = 1920 (true +ve)
Specificity: 94% =8000*94/100 =7520 (true –ve)

2000-1920 =80 (false –ve)
8000-7520 =480 (false +ve)

Example (2):Disease prevalence 1%, population 10000, sensitivity 95%, specificity 85%.

TEST RESULTS	Infected	Non infected	Total
Positive	95	1485	1580
Negative	5	8415	8420
Total	100	9900	10000

- **Prevalence:1%** =1x10000/100 =100 (infected)
  10000-100 =9900 (non infected)
- **Sensitivity:95%** =100*95 =95 (true +ve)
- **Specificity:85%** =9900*85/100=8415 (true –ve)
  100-95 =5 (false –ve)
  9900-8415 =1485 (false +ve)

Example(3):Calculation using a fixed threshold or gold standard measure:

Somatic cell	Mastitis	Healthy	Total
Elevated SCC	40	190	230
Low SCC	10	760	770
Total	50	950	1000

- ***Prev.%*** *= 5*1000/100 =50 (mastitis cow*
  1000 -50 =950 (non mastitis (healthy) cow)
- ***Sensitivity 8 · %*** *=50*80 =40 (true reactor or elevated)*
- ***Specificity 80%*** *= 950*80/100 =760 (true non –reactors)*
  50-40 = 10 (false non reactors or slow SCC)
  950-760 =190 (false reactor or elevated SCC
- ***Positive predictive value*** *=40/230 =0.173 = 17.3%*
- ***Negative predictive value*** *=190/230 =0.826 = 82.6%*

Test Result (PTB)	Disease + Osteomyelitis	Disease – No Osteo	
Positive +	33		Total Test+ 37
Negative -			Total Test- 39
	Total D+ 50	Total D- 26	Total Subjects 76

PPV = .89
*____ / 37

Sensitivity = ___
____/_____

Specificity= ___
____/_____

NPV=_____
____/ 39

APPLICATION OF THE EPIDEMIOLOGICAL INVESTIGATION TO DISEASE PREVENTION AND CONTROL (RISK MANAGEMENT)

* **Disease** is derived from the old French "des-" and "aise", which means lack of ease or inconvenience. It describes an abnormality of the structure or function of a body organ or system. Conceptually, disease refers to the objective, medical model of ill-health.

* **Infection** is more specific and denotes a disease caused by an invading pathogen eg bacteria, viruses, fungi etc.

DISEASE CONTROL STRATEGIES:

1. **Exclusion / Prevention**: Keep it out of here"
2. **Control** : Keep it at an acceptable level"
3. **Eradication:** Get rid of it" The extinction of an infectious agent e.g. cattle plague.

I) PREVENTION.

The action of stopping disease from happening or arising

* **Disease prevention** is a procedure through which individuals, particularly those with risk factors for a disease, are treated in order to prevent a disease from occurring.

1. **Primary prevention***,* approaches that take place *before* disease occurs;
2. **Secondary prevention**, responses that take place *after* disease has occurred, as immediate responses to mitigate the short-term consequences of disease;
3. **Tertiary prevention**, long-term responses "to deal with the lasting consequences of disease and perpetrator treatment interventions."

SUCCESSFUL PREVENTION DEPENDS UPON :

1. a knowledge of causation ,
2. dynamics of transmission ,
3. identification of risk factors and risk groups ,
4. availability of prophylactic or early detection and treatment measures ,
5. an organization for applying these measures to appropriate persons or groups, and
6. continuous evaluation of and development of procedures applied

II) CONTROL:

- It refers to reducing the number of new infections, the number of animals currently infected, and the number of animals which become sick or die from a disease in a locality.
- This is achieved through deliberate efforts such as vaccines, medications, contact isolation, or other public health interventions.

- Malaria is a good example of a disease that can be controlled in local settings. You can't get rid of malaria entirely because the mosquito-borne parasites that transmit the disease can develop drug resistance.

III) ELIMINATION:

- Elimination means stopping the transmission of a disease in a specific geographic area or country, but not worldwide. Often, the first step toward disease elimination is disease control.

IV) ERADICATION:

- Disease eradication is the permanent reduction of a disease to zero cases through deliberate measures such as vaccines. Once a disease has been eradicated, intervention measures are no longer needed. The only disease to ever be fully eradicated in human history has been smallpox, which was declared officially eradicated by the World Health Organization (WHO) in 1980.

Difference between control and eradication

	Control	Eradication
Definition	To reduce incidence to acceptable level e.g. malaria control	Total cessation of disease agent, e.g. Small Pox eradication
Objective	To reduce mortality and morbidity	To uproot the disease
Area of operation	In high incidence area	Total coverage
Duration of operation	Long follow up	Time limited
Economic aspect	Expensive	Cheap
Case finding, confirmation, Epidemiological investigation	Not important	Very important

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PRACTICAL NOTES ON:

PRINCIPLES OF VETERINARY EPIDEMIOLOGY

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Epidemiological studies aim at investigating the distribution and causes of the diseases in population.

Epidemiological studies are conducted to investigate causes of different diseases in either prospective approaches (cause to effect) or retrospective approaches (effect to cause).

Prospective studies are known as COHORT studies and retrospective studies are known as CASE CONTROL studies.

TYPES

ANALYTICAL EPIDEMIOLOGY

CASE CONTROL STUDIES COHORT STUDIES •Individuals with particular disease --- Cases •Individuals without particular disease --- Controls PROSPECTIVE COHORT STUDY Presence or absence of a particular disease TIME Factor(s) present / Absent Individual exposed to particular (s) / individual unexpected to particular factor(s)

COHORT STUDIES • In cohort design a longitudinal approach is used to investigate the occurrence of a disease in existing presumed causes. • Eg., Observation of smokers for lung cancer.

CASE CONTROL STUDIES • In this case causes of a disease are investigated after the occurrence of a disease. • Eg., Investigation of history of smoking in patients diagnosed with lung cancer.

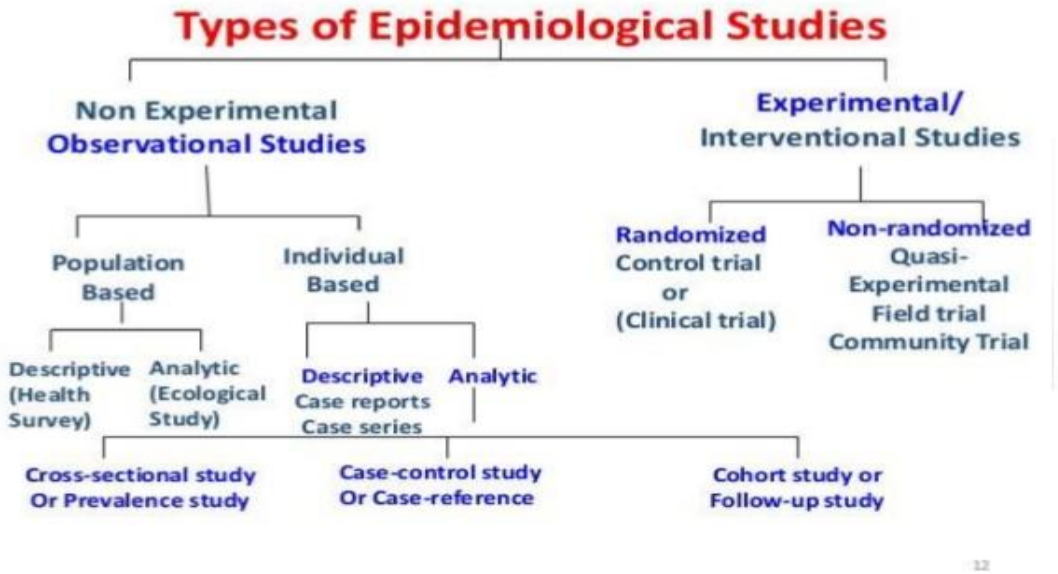
EPIDEMIOLOGICAL STUDIES

DEFINITION:

- A study that compares 2 groups of people who are alike except for one factor, s uch asexposure to a chemical or the presence of a health effect; the investigato rs try to determine if any factor is associated withthe health effect

- *To determine distribution of disease "Descriptive Epidemiology"*
- *To examine determinants of disease*
- *To identify whether a given exposure causes or prevent a disease "*
  Analytical disease "

TYPE OF EPIDEMIOLOGICAL STUDIES:



OBSERVATIONAL STUDIES = Investigator has no control over exposure

- DESCRIPTIVE
  - Case reports & case series (Clinical)
  - Cross-sectional (Epidemiological)
- ANALYTICAL
  - Cohort -Case-control - Ecological
- CASE REPORTS: One case of unusual findings
- CASE SERIES : multiple cases of findings

1. CROSS-SECTIONAL STUDY

- A study that includes all persons, in the population, at the time of ascertainment, or a representative sample of such persons. Disease and exposure are observed simultaneously.

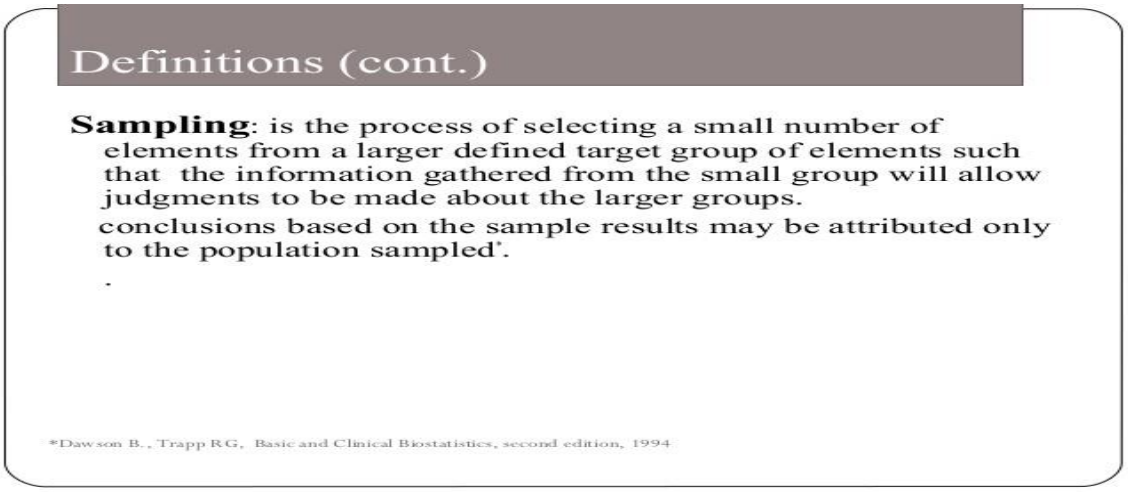
2. COHORT STUDY

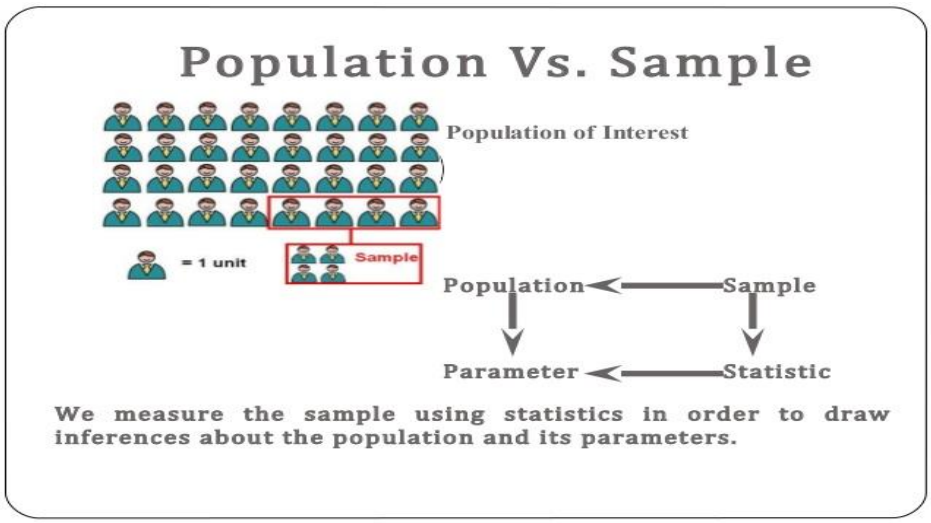
- Two groups (or more) groups of people that are free from the disease and that differ according to the extent of their exposure to a potential cause of the diseases are studied during a time interval.

3. CASE-CONTROL STUDY

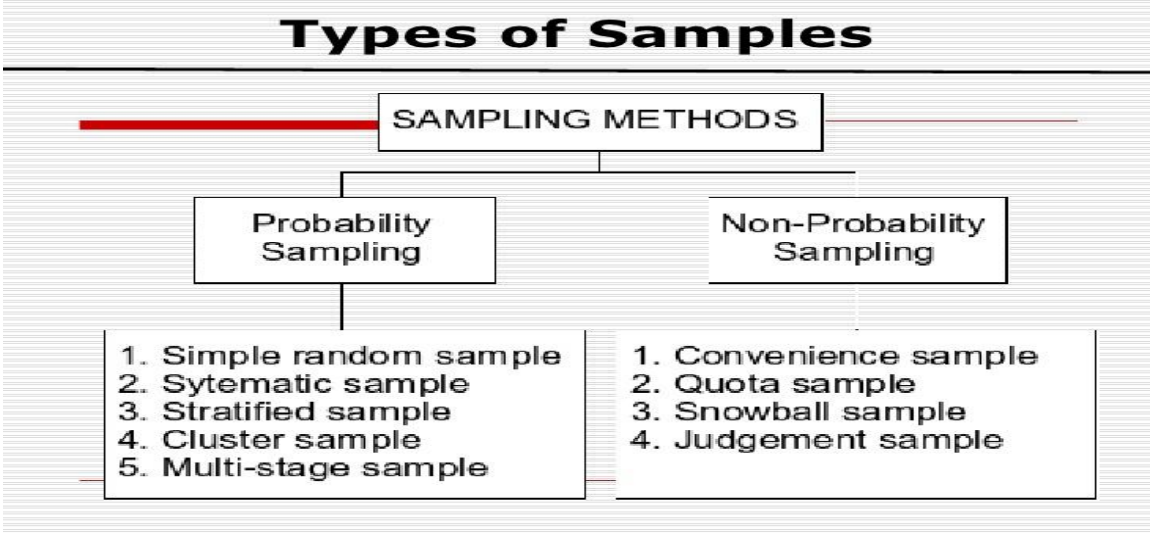
- A case control study includes people with a disease and a suitable control group of people unaffected by the disease. The occurrence of the possible cause (exposure) is compared between cases and controls. A relevant situation is to think of a case-control study as a cohort study where exposure is investigated for all cases and for a sample of the non-cases.

METHODS OF SAMPLING FROM A POPULATION





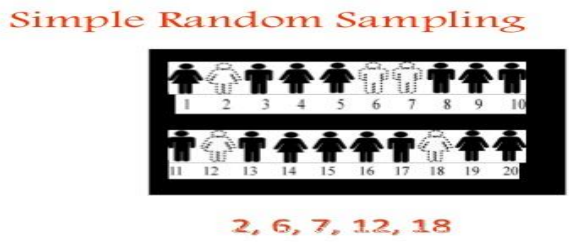
THERE ARE SEVERAL DIFFERENT SAMPLING TECHNIQUES AVAILABLE.



A) PROBABILITY SAMPLING

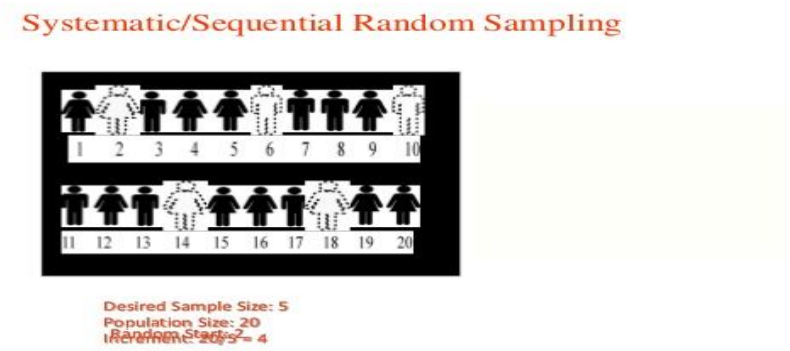
1. SIMPLE RANDOM SAMPLING

- In this case each individual is chosen entirely by chance and each member of the population has an equal chance, or probability, of being selected. One way of obtaining a random sample is to give each individual in a population a number, and then use a table of random numbers to decide which individuals to include.1



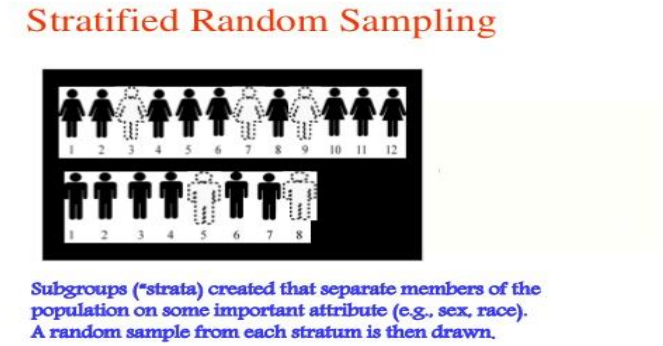
2. SYSTEMATIC SAMPLING

- Individuals are selected at regular intervals from a list of the whole population. The intervals are chosen to ensure an adequate sample size. For example, every 10th member of the population is included. This is often convenient and easy to use, although it may also lead to bias for reasons outlined below.



3. STRATIFIED SAMPLING

- In this method, the population is first divided into sub-groups (or strata) who all share a similar characteristic. It is used when we might reasonably expect the measurement of interest to vary between the different sub-groups. Gender or smoking habits would be examples of strata. The study sample is then obtained by taking samples from each stratum.
- In a stratified sample, the probability of an individual being included varies according to known characteristics, such as gender, and the aim is to ensure that all sub-groups of the population that might be of relevance to the study are adequately represented.1
- The fact that the sample was stratified should be taken into account at the analysis stage.



4. CLUSTERED SAMPLING

- In a clustered sample, sub-groups of the population are used as the sampling unit, rather than individuals. The population is divided into sub-groups, known as clusters, and a selection of these are randomly selected to be included in the study. All members of the cluster are then included in the study. Clustering should be taken into account in the analysis.

- The General Household survey, which is undertaken annually in England, is a good example of a cluster sample. All members of the selected households/ clusters are included in the survey.

B) PROBABILITY SAMPLING

1. CONVENIENCE SAMPLING

- Convenience sampling is perhaps the easiest method of sampling, because participants are selected in the most convenient way, and are often allowed to chose or volunteer to take part. Good results can be obtained, but the data set may be seriously biased, because those who volunteer to take part may be different from those who choose not to.

BIAS IN SAMPLING

- There are five important potential sources of bias that should be considered when selecting a sample, by whatever method:
  1. Any changes from the pre-agreed sampling rules can introduce bias
  2. Bias is introduced if people in hard to reach groups are omitted
  3. Replacing selected individuals with others, for example if they are difficult to contact, also introduces bias
  4. It is important to try and maximise the response rate to a survey; low response rates can introduce bias

MEASURES OF DISEASE FREQUENCY:

PREVALENCE is the number of cases of a disease in a defined population. The Prevalence can be measured by a prevalence rate, i.e., the proportion of the population that has the disease at a specific time. This can be measured by in a cross-sectional study.

INCIDENCE Is the number of new cases of disease in a population. The incidence can only be measured by considering a population during a time interval. It can be Measured by the incidence rate. The incidence rate is defined as

(The number of new cases in the population during the time considered)/(the total number of years that people are under risk do develop the disease).

CUMULATIVE INCIDENCE is the number of people in a cohort that gets the disease during the time of study.

- The relation between prevalence and incidence is somewhat complicated. It depends on the duration of the disease state. An approximate relation is
- P = I D
  Where D is the mean duration which diseased people carry the disease?
- If D is increased (e.g. the mortality is lowered by new medicines or if the disease is Diagnosed at an earlier state) the prevalence rate increases even if the incidence rate is the same.

DIAGNOSIS OF EPIDEMIC DISEASE

- The diagnosis of any health problem depends mainly on; the real knowledge and experience of veterinarian besides diagnostic tests which represents the basis for taking a decision when handling a health problem.

SCREENING TESTS:

- Screening is the identification of unrecognized disease by application of rapid tests to separate healthy animals which probably have the disease from those do not have the disease. (Main concern is with asymptomatic healthy individuals.
- Individuals with positive results should be referred for diagnosis and treatment (A screening test is not intended to be diagnostic).
- Theoretically, if a disease still at an early stage the chances are that cure is good.

SCREENING VS. DIAGNOSTIC

- Screening tests aim to detect the disease that has not been determined to be, or is suspected of being present. Test examples: temperature, California mastitis test, Tuberculin test.
- Diagnostic tests aim to test animals which have a symptom or other evidence of potential disease. Test examples: chest x-ray, biopsy, blood/urine test, colonoscopy.

Difference between screening and diagnostic tests:		
	Screening tests	Diagnostic tests
1.	Done on apparently healthy population to detect potential cases or indicators.	Done on those with signs of a disease to establish presence or absence of disease.
2.	Applied to a community or group of people	Applied to individuals
3.	Based on one criterion or cut-off point	Based on evaluation of a number of evidences like symptoms, signs, and investigations.
4.	Generally less accurate and relatively less expensive	More accurate but also more expensive
5.	Not a basis of treatment	Forms a basis to initiate treatment
6.	Initiative comes from the investigator	Initiative comes from a patient.
7.	Simple, acceptable to patients and staff	May be invasive and cumbersome
8.	Generally chosen towards high sensitivity not to miss potential disease	Chosen towards high specificity

QUALITY OF SCREENING TESTS DEPENDS ON:

1. **Validity**: ability of the test to distinguish between who has a disease and who does not
2. **Reliability:** A perfectly reproducible method of disease ascertainment would produce the same results every time it was used in the same individual.

Validity Components (expressed as percentages):

a. **Sensitivity** :the ability of the test to identify correctly those who have the disease; the search for diseased persons

b. **Specificity:** the ability of the test to identify correctly those who do not have the disease; the search for well individual

No test has 100% accuracy; so screening tests give us apparent not the true prevalence. Need to know the sensitivity and specificity of the test to calculate true prevalence.

DIAGNOSTIC TEST

- ❖ Is the basis for taking a decision when handling a health related problem?
- ❖ Diagnostic test decision is typically dichotomous, treat or does not treat / having the disease or do not having the disease, implement a control programme or not.
- ❖ The result of the test can condensed into a cut-off value as a continuous scale.

Question (1): Estimated and true prevalence of a disease agent illustrating the terms sensitivity and specificity (2 X 2 Table)

Test result	infected individuals	non infected individuals	Total
Positive	(a) True positive	(b) False positive	a + b
Negative	(c) False negative	(d) True negative	C + d
Total	a + c	b + d	N (a+ b+ c+ d)

- Sensitivity = a / a+c (+ve (diseased) / Total diseases.)
- Specificity = d/ b+d (- ve (not diseased)/ Total not diseased).
- The estimated prevalence = a + b / N
- The true prevalence = a + c / N

Q (2): Sample of 10,000 animals was tested for the presence of a disease using a test of 96% sensitivity and 94% specificity and diseased prevalence (true prevalence) 20%.

Results	Infected	Non infected	Total
Positive	1920	480	2400
Negative	80	7520	7600
Total	2000	8000	10000

- Prevalence: 20% = 20 x 10000/100 = 2000 (Infected)
- Sensitivity 96% = 2000 x 96/100 =1920 (True + ve)
- Specificity 94% = 8000 x 94 / 100 = 7520 (True – ve)

Q (3): Disease prevalence 1%, population10000, sensitivity 95%, and specificity 85 %.

results	**Infected**	**Non infected**	**Total**
Positive	95	1485	1580
Negative	5	8415	8420
Total	100	9900	10000

- Prevalence. 1% = 1 x 10000 / 100 = 100 (Infected)
- Sensitivity 95% = 100 x 95 = 95 (True + ve)
- Specificity 85 % = 9900 x 85/100 = 8415 (True – ve).

Q (4): Calculation using a fixed threshold or gold standard measure

Somatic cells	Mastitis	Healthy	Total
Elevated SCC	40	190	230
Low SCC	10	760	770
Total	50	950	1000

- Prev.5% = 5 x 1000/100 = 50 (Mastitis cows)

- 1000 – 50 = 950 (Non mastitis (healthy) cows
- Sensitivity 80 % = 50 x 80 =40 (true reactor or elevated)
- Specificity 80% =950 x 80/ 100 =760 (True non – reactor)
- Positive predictive value = 40 / 230 = 0.173 = 17.3 %
- Negative predictive value =190/ 230 = 0.826 = 82

INVESTIGATION OF DISEASE OUTBREAK IN POPULATION

WHAT IS AN OUTBREAK?

Occurrence of more cases of disease than expected

- in a given area
- among a specific group of people over a particular period of time

EPIDEMICS OCCUR WHEN.

Host, agent and environmental factors are not in balance due to new agent

1. due to change in existing agent (infectivity, pathogenicity, virulence)
2. due to change in number of susceptible in the population
3. Due to environmental changes that affect transmission of the agent of growth of the agent.

WHY INVESTIGATE OUTBREAKS?

- Stop the outbreak
  - Find and neutralise the source (cause)
  - Prevent additional cases
- Prevent future outbreaks
- Improve surveillance and outbreak detection
- Training

FACTORS COMMONLY ASSOCIATED WITH THE OCCURRENCE OF ANIMAL OUTBREAKS:

1. Mutation of organism to new serovar (antigenic type)
2. Migration of humans and animals into new environments
3. Climatic changes: Wind, Rainfall, etc
4. War and natural disasters
5. Decline or impairing in vaccination rates
6. Stress factors (e.g., contaminated feed, air pollution,etc)

OUTBREAK INVESTIGATION TEAM

If an outbreak is suspected an Outbreak Control Team (OCT) should be convened to conduct the investigation with the following represented in the membership;

- Consultant in Communicable Disease Control (CCDC)/Consultant in Health Protection (CHP)
- Environmental Health Officer (EHO)
- Consultant Microbiologist or Virologist
- Secretarial/Administrative support

WITH CONSIDERATION OF:

- Regional epidemiologist
- Media/press officer
- Local veterinary service
- Food chemist/microbiologist/Food Standards Authority
- Director of Public Health
- Water company