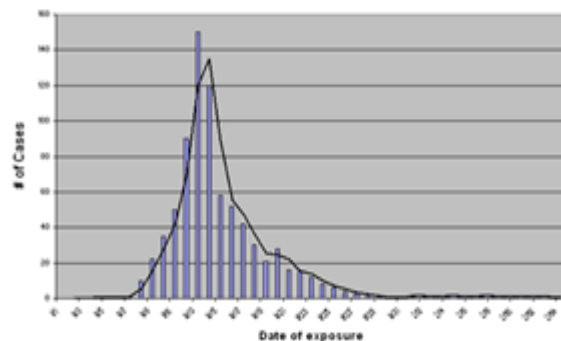
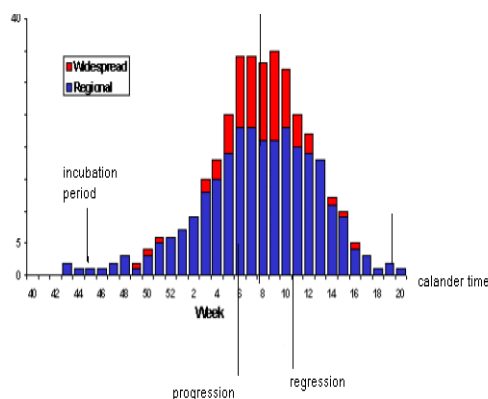


NOTES ON:

PRINCIPLES OF VETERINARY EPIDEMIOLOGY

BASIC EPIDEMIC THEORY (EPIDEMIC CURVE)

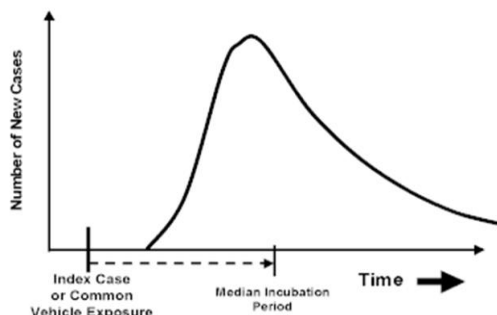
- * **EPIDEMIC CURVE** : A graph in which the number of new cases of a disease is plotted against an interval of time to describe a specific epidemic or outbreak. The shape of the epidemic curve may suggest what kind of outbreak is occurring.



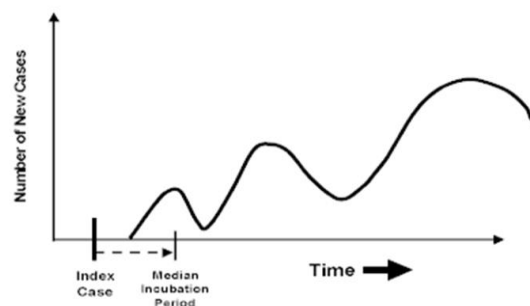
THE OVERALL SHAPE OF THE EPI-CURVE CAN REVEAL THE TYPE OF OUTBREAK

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



1) **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.

A) 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.

B) 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.

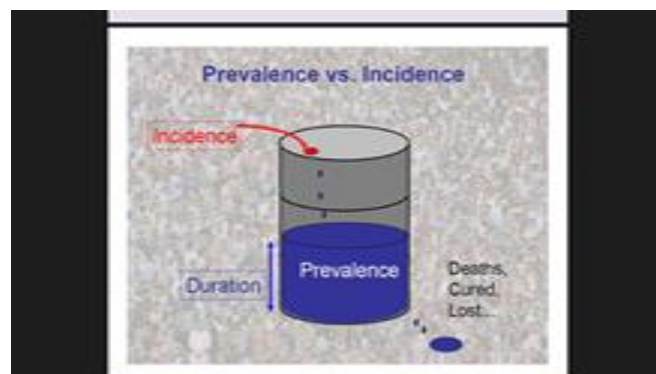
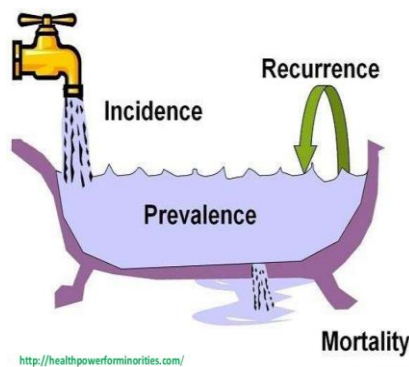
$$\text{CI} = \frac{\text{No of individuals become disease during particular time}}{\text{No of healthy individuals at the beginning of that period}} \times 100$$

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". $P = I \times D$.
- ❖ 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.

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

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 = $(400 / 1000) \times 100$ = 40 %
- * **C I from** 1 March, 2017 to 1 July, 2018 $(200/1000) \times 100$ = 20%
- * **Mortality rate** = $(120/ 1000) \times 100$ = 12 %
- * **Case fatality rate** = $(120 / 600) \times 100$ = 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

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

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

1. Done on apparently healthy individuals
2. Applied to groups
3. Results are arbitrary and final
4. Based on one criteria and cut-off
5. Less accurate
6. Less expensive
7. Not a basis for treatment
8. Initiative comes from investigator

Diagnostic test

1. Done on sick or ill individuals
2. Applied on single patient
3. Diagnosis is not final
4. Based on evaluation of a no. of signs/symptoms & lab findings
5. More accurate
6. More expensive
7. Used as a basis for treatment
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, the 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) Sick cell anemia – CBC, Hb electrophoresis
5. Case finding screening

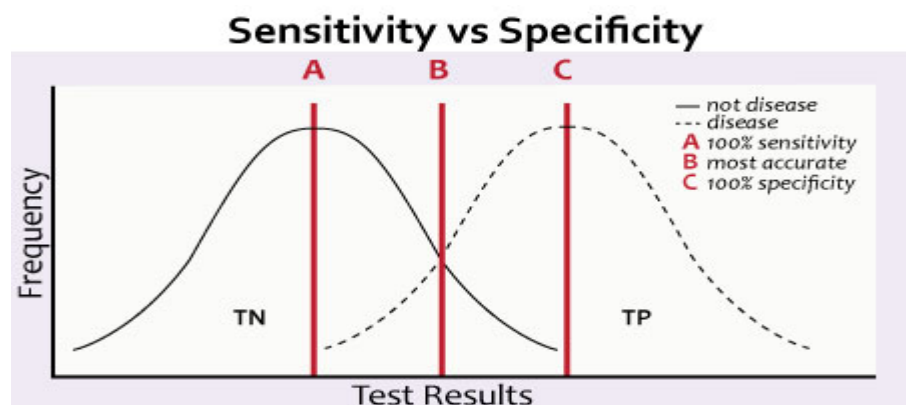
QUALITY OF SCREENING TESTS

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	
		+	-
T E S T	+	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

		"Truth" or "Gold Std" test		
		Pos	Neg	
Your test	Pos	a	b	a+b
	Neg	c	d	c+d
		a+c	b+d	Total a+b+c+d



SENS

Sens = $\frac{a}{a+c}$

Spec = $\frac{d}{b+d}$

