TEST EVALUATION

A test may be defined as any process or device designed to detect (or quantify) a sign, substance, tissue change, or body response in an animal. The two key requirements of a diagnostic test are: (1) the test will detect diseased animals correctly, and (2) the test will detect non-diseased animals correctly.

To work out how well a diagnostic test performs, we need to compare it with a 'gold standard.' A gold standard is a test or procedure that is absolutely accurate. It diagnoses all diseased animals that are tested and misdiagnoses none. Once samples are tested using the gold standard and the test to be evaluated, a 2 × 2 table can be constructed, allowing test performance to be quantified.

2 X 2 CONTIGENCY TABLE

	Diseased	Non-diseased	Total
Test positive	a	b	a +b
Test negative	c	d	c + d
Total	a + c	b + d	a + b + c + d

SENSITIVITY

The sensitivity of a test is defined as the proportion of subjects with disease that test positive. A sensitive test will rarely misclassify animals with the disease. It is the proportion of animals with disease that have a positive test for the disease. It can also be referred to as the true positive rate (relative to all animals with disease).

SPECIFICITY

The specificity of a test is defined as the proportion of subjects without the disease that test negative. A highly specific test will rarely misclassify animals without the disease.

Specificity is:

- The conditional probability of a negative test, given the absence of disease.
- The likelihood of a negative test in an animal without disease.

- The proportion of animals without the disease that have a negative test for the disease.
- The true negative rate (relative to all animals without disease).

Sensitivity and specificity are inversely related and in the case of test results measured on a continuous scale they can be varied by changing the cut-off value. In doing so, an increase in sensitivity will often result in a decrease in specificity, and vice versa. If the primary objective is to find diseased animals (that is, to minimise the number of false negatives and accept a limited number of false positives) a test with a high sensitivity and good specificity is required.

If the objective is to make sure that every test positive is 'truly' diseased (minimise the number of false positives and accept a limited number of false negatives) the diagnostic test should have a high specificity and good sensitivity

Positive Predictive Value

The positive predictive value is the proportion of subjects with positive test results which have the disease.

The predictive value of a positive test is the post test probability of disease following a positive test**.**

Negative Predictive Value

The negative predictive value is the proportion of subjects with negative test results which do not have the disease.

Negative predictive value is:

• The predictive value of a negative test.

• The post test probability of no disease following a negative test.

Sensitivity and specificity are generally independent of prevalence. If the prevalence increases, positive predictive value increases and negative predictive value decreases. If the prevalence decreases, positive predictive value decreases and negative predictive value increases. The more sensitive a test, the better its negative predictive value. The more specific a test, the better its positive predictive value.

EPIDEMIOLOGICAL INVESTIGATIONS

Epidemiological investigations are normally conducted in a series of stages, which can be broadly classified as follows:

1. A diagnostic phase, in which the presence of the disease is confirmed.

2. A descriptive phase, which describes the populations at risk and the distribution of the disease, both in time and space, within these populations. This may then allow a series of hypotheses to be formed about the likely determinants of the disease and the effects of these on the frequency with which the disease occurs in the populations at risk.

3. An investigative phase, which normally involves the implementation of a series of field studies designed to test these hypotheses.

4. An experimental phase, in which experiments are performed under controlled conditions to test these hypotheses in more detail, should the results of phase 3 prove promising.

5. An analytical phase, in which the results produced by the above investigations are analysed. This is often combined with attempts to model the epidemiology of the disease using the information generated. Such a process often enables the epidemiologist to determine whether any vital bits of information about the disease process are missing.

6. An intervention phase, in which appropriate methods for the control of the disease are examined either under experimental conditions or in the field. Interventions in the disease process are effected by manipulating existing determinants or introducing new ones.

7. A decision-making phase, in which knowledge of the epidemiology of the disease is used to explore the various options available for its control. This often involves the modelling of the effects that these different options are likely to have on the incidence of the disease. These models can be combined with other models that examine the costs of the various control measures and compare them with the benefits, in terms of increased productivity, that these measures are likely to produce. The optimum control strategy can then be

selected as a result of the expected decrease in disease incidence in the populations of livestock at risk.

8. A monitoring phase, which takes place during the implementation of the control measures to ensure that these measures are being properly applied, are having the desired effect on reducing disease incidence, and those developments that are likely to jeopardise the success of the control programme are quickly detected.

Disease Surveillance and Monitoring

Surveillance: Is the act of collecting data and using it to implement action. It provides important knowledge to epidemiologists about the occurrence of disease and events in the population; whether it is the frequency or distribution of a disease in a population or the use of a specific drug or device. Surveillance incorporates various methods of collecting data, analyzing and interpreting the data, and then initiating some form of action; either preventive or for the purpose of intervention. This action also includes the dissemination of information to health professionals and the public. A surveillance system is a collection of activities that complement each other, e.g. case finding, disease reporting, and laboratory confirmation.

The characteristics of effective surveillance system are as follows:

1. High detection rate: The system should be able to detect as many disease events as possible.
2. Sensitive and specific

- Sensitivity is the number of true cases a system correctly identifies out of the total number of truly diseased subjects studied. The higher the sensitivity of the system, the more truly diseased cases are identified (hence a lower number of false negative cases).
- Specificity is the number of non-diseased animals a system correctly identifies out of the total number of truly non-diseased subjects examined. The higher the specificity

of a system, the more truly non-diseased animals identified (hence a lower of false positive cases).

3. Timely: The system should be able to detect, investigate provide feedback and allow for action on a suspect disease event within a timeframe relative to the infectious cycle of the disease.
4. Representative: The system should reflect the truly occurrence and distribution of the event in all communities, production systems and social strata.
5. Flexible: the system should be able to detect and accommodate emerging diseases.
6. Simple: If the procedures are too difficult farmers and surveillance staff will probably not be motivated to report, act and control suspect disease events.
7. Ownership: Stakeholders should feel a sense of ownership based on their participation in the design of the system and the relevance of the output to their needs.

In practice, no single surveillance system will have all these seven characteristics, so a surveillance system must integrate different activities to meet stakeholders' needs and achieve its goals and technical objectives.

Monitoring: Is a less intensive form of surveillance. Monitoring programs are normally done just to collect information on a general basis.

Types of Surveillance

Surveillance is considered Active or Passive according to the data collected.

Passive Surveillance: Is an established system that collates reports that are sent by health professionals to health departments or disease registries. These systems are easy to maintain and are inexpensive.

Active Surveillance: Requires the health departments to go out and collect detailed information on a specific disease or problem at a given point in time. This surveillance type is money and labour-intensive, but collects much more detailed data.

Monitoring and surveillance are often used interchangeably because they are similar, but they have different meanings and goals. Monitoring is basically an observation and collection process. It is important for increasing knowledge about disease and/ population. Monitoring involves the observation and analysis of a disease or events to accomplish the goal of detecting

changes in the frequency or distribution in the population. It involves the collection of complete information for assessment but usually determines the occurrence of an event or a disease less rapidly than a surveillance program.

Surveillance on the other hand, is more active in the analysis, interpretation, and action on the results of the data collected. It is a systematic approach of collecting, analyzing, and interpreting data, with the goal to initiate control measures or further investigative programs. Surveillance can include any aspect relevant to the control of disease(s). It is important to interpret the data quickly to initiate further action, therefore the process attempts to determine as early as possible the occurrence and distribution of a disease or an event in a population. The information collected is then disseminated to health professionals or to the public.

Surveillance can be initiated to test a specific hypothesis, to survey a general or specific population, to survey disease indicators such as the animal population or reservoirs or vectors of disease, or to survey drug, and biologic utilization of the population. During the planning and in the evaluating of a surveillance system, there are several issues to keep in mind: the usefulness, the flexibility and the simplicity of the system, the representativeness, the timeliness, and the accuracy and quickness of the detection of new cases or epidemics.

Sources of data for surveillance: These are very important for the surveillance process. The most common sources of data are mortality records, or death certificates, morbidity reporting or reportable diseases required by law, the reporting of epidemics and field investigations, laboratory investigations and surveys. Each source has advantages and disadvantages when used for surveillance purpose. Death certificates are a good source because a denominator or population at risk can be calculated with the census data. In addition death certificates are fairly standardized, easy to obtain, and include other basic demographic information such as age, gender, race, and occupation; hence they can be used by researchers as an indicator of certain disease frequencies in the population.

Two disadvantages of death certificates are the inconsistent coding of diagnoses by different professionals, and the fact that highly fatal diseases are more likely to be represented. Also,

death certificates request coding of primary and secondary causes of death. The interpretation, and therefore the listing of primary versus secondary causes, may differ among individuals filling out the certificates. This difference in interpretation and listing can influence the measurement of a particular disease. The primary cause of death for example, may be listed for an individual as pulmonary oedema, and the secondary cause as coronary heart disease: when in actuality, coronary heart disease is the primary disease that causes the pulmonary oedema. For the study of occupational disease, death certificates provide both a source of the mortality and the occupation of individuals. Mortality ratios can be calculated and compared for each occupational group. Sometimes more information can be collected from the listed employers.

Each surveillance program must be planned to meet a particular objective. For infectious disease surveillance, the objectives are to identify newly diagnosed cases and high-risk groups; to understand the mode of transmission, and to control or eliminate disease transmission. Surveillance can collect baseline incidence data to detect the occurrence of an epidemic. Seasonal, temporal, geographic, and sub-group patterns are important for understanding the mode of transmission and for determining ways in which to control the disease. Seasonal and temporal trends can give information about times in which control programs should be initiated/ implemented. Geographic and subgroup patterns help epidemiologists focus control programs in the most effective areas.

The pervasive problems that occur with any surveillance system are underreporting, lack of representativeness, inconsistency in definition, and the lag time between the occurrence of any event, and the actual reporting. Most surveillance systems consist of events that are underreported unless there is aggressive/ active solicitation of reports of a particular disease or event. Normally medical professionals do not report a disease or an event unless it is serious or of specific interest. This kind or reporting can lead to reports in a system from those most interested, and may not be representative of the general population. Reporting from various sources usually has inherent differences in diagnosis or definition of a disease. Finally, in any

surveillance system there is a period of time that passes between the event and the time it gets reported.

The design and management of surveillance activity of a National Animal Health services is usually the responsibility of the Veterinary Epidemiology or Epizootiology section. The section utilizes the result of its data analysis for:

i. Assessing the need for, progress of disease control in control eradication programme at farms, area, regional and national level.
ii. National and International reporting of disease statistics
iii. Developing and motoring National Animal Health programmes
iv. Developing and monitoring quarantine policy.
v. Facilitating export trade in animals and their by-products.

This is assuming greater significance as efforts to reduce non-traffic, barrier in international trade programme. The evidence needed by a country to support and justify imposition of quarantine barrier is its ability to document freedom from some particular disease, evidence of which can only be provided by efficient surveillance. Similarly, evidence of economic impact of a condition is required to persuade politicians/government to finance a control campaign; this may also come from the data of a surveillance programme.

CLIMATE CHANGE AND SPREAD OF DISEASES

Climate change could cause changes in the incidence of infections diseases. Higher ambient temperatures may result in an increase in some temperature sensitive food borne diseases such as gastroenteritis, paralytic shell fish poisoning and botulism.

An increase in mean temperature may influence the incidence of infectious diseases of animals that are spread to humans (zoonoses) by changing the population and range of animal hosts and insect vectors e.g. there is a particular breeding season of ticks leading to an increase in the incidence of tick borne infections e.g. babesiosis.

An increase in flooding events may result in outbreaks of water borne infections, such as *Giardia, lamblia* or *croptosporidium parvum*; which have been implicated in water borne outbreaks of diarrhoea following heavy rainfall.

A change in rodents and fox populations may result in an increase in rabies or echinococccosis. *E multilocularis* is a parasitic tapeworm, the life cycle of which involves foxes, dogs and rodents, whose range could vary with a changing climate. Humans are incidentally infected when they ingest eggs passed by dogs or foxes.

Recommendations

To detect and respond to changes in infections disease epidemiology caused by climate change will require:

1. Strengthening public health infrastructure and ensuring surveillance for disease most likely to be influenced by climate with particular attention to those with potentially large public health
2. Monitoring of animal host and arthropod vectors involved in transmission of infectious disease and most likely to be influenced by climate change.
3. Early warning systems should be developed to generate public advisories and to generate preventive public health messages, such as use of insect repellents, boiling water & cooling before use e.t.c
4. Health care providers should be aware of the potential for the emergence of new pathogens in their regions and report unusual occurrences to public health officials.