GUIDELINE

Basic Epidemiological Principles

There are several key definitions that must be understood when considering the interpretation and accuracy of any test results, including prevalence, sensitivity, specificity, and positive and negative predictive values.

Prevalence is defined as the total number of cases of a particular disease or condition found in a population at a given time and is reported as a proportion or percentage. It is a measurement of all individuals affected at a particular time and is distinct from incidence, which measures all new cases over a certain period of time. For example, if 15 of 75 cats in a shelter were found to have an upper respiratory infection (URI), the prevalence of URI would be 20%.

Sensitivity describes a test's or procedure's ability to detect the condition in question and provides an indication of how "good" it is at finding all of the cases being investigated. Very sensitive tests are highly unlikely to miss truly affected animals. They have a very low rate of false negatives or affected animals incorrectly identified as being healthy. Most negative results will be true negatives when a test with high sensitivity is used.

Specificity describes a test's or procedure's ability to detect only the particular condition in question and provides an indication of how "good" it is at finding only the cases of interest in those being investigated. Very specific tests are highly unlikely to misidentify animals with conditions other than the disease in question. They have a very low rate of false positives, or healthy animals incorrectly identified as being affected. Most positive results will be true positives when a test with high specificity is used.

Sensitivity and specificity thus have a direct impact on the interpretation of the results obtained from a particular test, which is also impacted by the prevalence of the condition in question.

The **positive predictive value (PPV)** of a test, sometimes referred to as the precision rate, is defined as the likelihood that an animal testing positive for the condition actually has that condition. It is the proportion of true positives out of all positive results and gives an indication of how trustworthy a positive result can be considered.

The **negative predictive value (NPV)** of a test is the likelihood that an animal testing negative for a condition does not, in fact, have that condition. It is the proportion of true negatives out of all negative results and gives an indication of how trustworthy a negative result can be considered.

The simplest way to calculate the positive and negative predictive values for any particular test is to compare the ratio of true positives with all positive results and true negatives with all negative results, respectively. However, due to various constraints, we are not always in a position to know which results are erroneous, which limits the utility of this equation. When the true disease state is unknown, the clinician can use information on disease prevalence and the sensitivity and specificity of the test in question to determine the NPV and PPV using the equations below. Such calculations serve as an indicator of how reliable a particular animal's results can be considered.

$$PPV = \frac{(\text{sensitivity})\,(\text{prevalence})}{(\text{sensitivity})\,(\text{prevalence}) + (1 - \text{specificity})(1 - \text{prevalence})}$$

$$NPV = \frac{(\text{specificity})\,(1 - \text{prevalence})}{(\text{specificity})\,(1 - \text{prevalence}) + (1 - \text{sensitivity})(\text{prevalence})}$$

This information can also be used to determine the relative efficiency of particular testing or screening protocols to maximize the effective use of resources. When screening for common conditions, positive results can generally be relied upon, provided the test used has a high specificity value, but negative results should be evaluated closely, and additional testing may be indicated. When screening for uncommon conditions, negative results can generally be relied upon, provided the test used has a high sensitivity value, but positive results should be evaluated closely, and additional testing may be indicated.

Figure 1 shows a visual representation of the relationship between the presence or absence of disease, test results, sensitivity, specificity, and predictive values.

Figure 1. Interactions between sensitivity, specificity, true conditions, and test results