

Understanding Laboratory Results

Every attempt is made to ensure that all results issued from the Virology Division (CVRL) maintain the highest standards of quality and reliability. However each “real-world” assay has certain inherent “real-world” limitations. It is important that all laboratory results are interpreted with this in mind and in context - rarely is a single laboratory result sufficient for radical action.

The most common laboratory results are positive, negative or inconclusive.

Generally a **positive** result confirms the presence of either specific virus **or** specific antibody to a virus. A positive virus result means the animal was infected at the time of sampling. It is a clinical judgement whether or not that this is relevant to disease. A positive antibody result means the animal was previously infected **OR** still has maternally-derived passive antibody.

Generally a **negative** result means that the specific virus **or** specific antibody tested for was not detected.

An **inconclusive** result means that the test result was not clearly positive or negative. Sometimes reported as doubtful or suspect.

A **false positive** result indicates that a virus or antibody is detected when it is not actually present in the sample. Similarly a **false negative** result indicates that a virus or antibody is not detected when it is actually present in the sample.



Concepts of test performance

Sensitivity

How well a particular test can detect a virus or antibody

Example: how many cattle truly infected with a virus will a particular laboratory test correctly identify as positive OR how many cattle with an antibody to a particular virus will be identified as positive?

$$\text{Sensitivity} = \frac{\text{TruePositives}}{\text{TruePositives} + \text{FalseNegatives}}$$

Specificity

Is the particular test only positive when the particular virus or antibody is present

Example: how many cattle truly free of a particular antibody or virus will a particular laboratory test correctly identify as negative.

$$\text{Specificity} = \frac{\text{TrueNegatives}}{\text{TrueNegatives} + \text{FalsePositives}}$$

Accuracy

How close to the actual true “real world” value is the particular test result – does a particular test result give a true reflection of the likely viral or antibody level ?

Precision

How repeatable is a particular test result – does a particular test consistently give the same result ?



There are many other measures of laboratory test performance such as predictive values, likelihood ratios, ROC values, etc.

The following are recommended reading on this topic.

1. Gardner IA , Greiner M. - Receiver-operating characteristic curves and likelihood ratios: improvements over traditional methods for the evaluation and application of veterinary clinical pathology tests. - *Vet Clin Pathol* 2006 Mar; 35: 8-17.
2. Loy CT, Irwig L. - Accuracy of diagnostic tests read with and without clinical information: a systematic review. - *JAMA* 2004 Oct 6; 292: 1602-1609.
3. Bossuyt X. - Clinical performance characteristics of a laboratory test. A practical approach in the autoimmune laboratory. - *Autoimmun Rev* 2009 Jun; 8: 543-548.
4. Burr P, Snodgrass D. Demystifying diagnostic testing: serology. *In Practice* 2004; 26: 498-502.
5. Drobatz K J. - Measures of accuracy and performance of diagnostic tests. - *J Vet Cardiol* 2009 May; 11 Suppl 1: S33-S40.
6. Fardy J M. - Evaluation of diagnostic tests. - *Methods Mol Biol* 2009; 473: 127-136.
7. Florkowski C M. - Sensitivity, Specificity, Receiver-Operating Characteristic (ROC) Curves and Likelihood Ratios: Communicating the Performance of Diagnostic Tests. - *Clin Biochem Rev* 2008 Aug; 29 Suppl 1: S83-S87.
8. Schulzer M. - Diagnostic tests: a statistical review. - *Muscle Nerve* 1994 Jul;17: 815-819.
9. Webster K. Demystifying diagnostic testing: non-culture techniques for large animal infectious disease. *In Practice* 2004; 26: 325-330.



Although modern laboratory test and assays commonly have high sensitivities, high specificities, and are usually both accurate and precise – they are not absolutely perfect. No test is 100% sensitive and specific. It is the responsibility of every testing laboratory to constantly monitor and update testing arrangements to minimise such errors and the responsibility of the clinician to appreciate the strengths and weaknesses of tests and not to over-interpret them.

Actions on samples outside the laboratory can also have a major effect on test performance.

Tips to maximise testing performance

Ensure that all blood tubes are filled – this will provide sufficient material for either retesting or further confirmatory tests, should the need arise.

Ensure that all sampling materials are transported to the testing laboratory as quickly as possible.

Transport at refrigerator temperature. If specimens must be frozen, avoid multiple freezing/ thawing cycles.

Ensure accurate labelling and identification.

For larger submissions, this means using handheld computers and then sending the relevant electronic files to the laboratory to enable logging-in.

If using a group submission, use marker-paint, tail-tape, etc to identify which animals were sampled – it is then much easier to resample.

Do not submit samples where haemolysis, lipaemia or bacterial contamination (odour, consistency, colour) are apparent. If such sub-standard samples are recognised, the laboratory will typically request a resampling.

Screening tests, involving pooling or “bulk” type samples, are used primarily for convenience and cost-effectiveness. In almost all cases, individual sampling and testing will give a more accurate profile of a herd’s infection/disease status.

If there is a deadline as to when a definitive result is required, ensure samples are collected and submitted earlier rather than later – in case resampling and retesting is necessary.

All disease control decisions should take into account the unique set of factors such as disease history, management practices, animal type, laboratory results, etc particular to the farm or holding in question.

Your local qualified veterinary surgeon is best placed to advise on the most effective course of action.

If in doubt, resample and resubmit.

