Meeting 6: Use of diagnostic tests and procedures

Reading

- Thrusfield 2nd Edn or 3rd Edn, Chapter 17 'Diagnostic testing'

- Dohoo et al, pp 85-120 'Screening and diagnostic tests'

- Toma et al (1999) Applied Veterinary Epidemiology and the control of disease in populations Chapter 2 pp 71-86 (herd level sensitivity and specificity)

Presentations

1. Characteristics of tests (sensitivity, specificity, accuracy, precision)

2. Positive and negative predictive values

3. Comparing tests and selection of appropriate diagnostic tests

4. Use of likelihood ratios

5. Herd level sensitivity and specificity

Exercises

1. Diagnosis of fascioliasis in cattle

   Two methods are being compared for the diagnosis of fascioliasis in cattle from the region around Hanoi in Vietnam. Between 3 and 8 samples are collected each week at a local abattoir from cattle of different age groups. These samples include whole liver and gall bladder for total counts of fluke, samples of faeces for fluke egg counts and blood for serum, to be used for an indirect antibody ELISA. So far, 95 livers have been collected, but of these, on 93 have matching serum samples and 65 have matching faecal samples. Of the animals with one or more fluke, 58 had positive and 15 negative results in the ELISA test, whereas in animals with no detectable fluke, 5 sera were positive and 15 negative for the ELISA. Similarly, 38 of the animals infected with fluke had positive egg counts for Fasciola species and 16 had zero counts. Eleven animals were not infected by fluke and all had zero counts for fluke eggs.

   Calculate the sensitivity and specificity for both tests, determine the apparent and true prevalence of fascioliasis in this population and decide on the usefulness of these tests for the diagnosis of fascioliasis in this region.

2. Read journal article Dionysius DA, 1991, Pregnancy diagnosis in diary goats and cows using progesterone assay kits, *Australian Veterinary Journal*, vol 68, no 1, pp 14-16.

   a. For cattle calculate the positive and negative predictive values for diagnosis of pregnancy using the Enzygost Vet test kit (Table 3). Assume a normal conception rate of 55% and no follow up heat detection for determination of pregnancy status.

   b. On the basis of these calculations how would you advise a farmer to interpret a positive and negative test.

3. A test with a sensitivity at the individual level of 99% is to be applied to a population, testing different numbers of animals according to the size of the herd:

> All the animals in herds of less than 20 head

> 50% of the animals in herds of 20-50 head

> 30% of the animals in herds of more than 50 head

What is the probability of missing herds with a low level of infection (only 1 infected animal)

Taken from Toma et al, 1999, *Applied Veterinary Epidemiology and the control of disease in populations* Chapter 2 pp 86

Example examination questions

1. Give a definition of test Se, Sp, PPV, NPV and describe the effect of the prevalence of disease on these values (2005 oral)

2. How can you improve the PPV or NPV? (2005 oral)

3. Describe the important attributes of screening tests (2005 oral)

4. What are the important features of tests used at the beginning and the end of an eradication program? How might you improve the test performance at the end of the eradication program? (2005 oral)

5. How would you compare two diagnostic tests? (2005 oral)

6. What is the difference between precision and accuracy of diagnostic tests? (2005 oral)

7. What is an ROC curve and what is it used for? (2005 oral)

8. Write brief notes to demonstrate your understanding of
   a. Interpretation of herd level sensitivity and specificity
   b. Parallel and series testing (2003 written)

9. Two test for ovine paratuberculosis (*Mycobacterium avium* subsp. *paratuberculosis*) have been developed. One test is an absorbed enzyme linked immunosorbent assay (ELISA) while the other is an agar-gel immuno-diffusino (AGID) test. You have been asked to evaluate these tests. To assist with the study sheep have been made available from farms where ovine paratuberculosis is known to be present and from farms in an area thought to be free. Histologic examination of internal tissue is regarding as the definitive test for ovine paratuberculosis.

   Describe how you would evaluate the performance of these tests (70% of marks). Include in your answer a discussion of how you might compare the performance of the tests (30% of marks).

Additional reading/resources

- Jacobson RH (1998) Validation of serological assays for diagnosis of infectious disease, Rev. sci. tech. Off. Int. Epiz. 17(2): 469-496

- Christensen J et al (2000) Herd level interpretation of test results for epidemiologic studies of animal disease, Prev Vet Med 45(1-2): 83-106

- Epidemiological Skills in Animal Health, PGFVS Proceedings 143; pp 87-95 (use and interpretation of tests at individual and herd level)

- Lehane R, Beating the odds in a big country, the eradication of bovine brucellosis and tuberculosis in Australia pp 46-49, 108-109, 240-241

- Sergent et al (2004) Epidemiological problem solving, Ausvet Series in Epidemiological Skills for Animal Health Professionals. pp 37-57 'Application of diagnostic tests'

- Pitt DJ et al. (2002) An estimate of specificity for a Johne's disease absorbed ELISA in northern Australian cattle. AVJ 80: 57-60.

- Sergeant ESG et al. (2002) Sensitivity and specificity of pooled faecal culture and serology as flock-screening tests for detection of ovine paratuberculosis in Australia. Prev Vet Med 52: 199-211.

- Enoe C et al. (2000) Estimation of sensitivity and specificity of diagnostic tests and disease prevalence when the true disease state is unknown. Prev Vet Med 45: 23-41.

- Greiner M et al. (2000) Principles and practical application of the receiver-operating characteristic analysis for diagnostic tests. Prev Vet Med 45: 61-81.

- Jordan D. (1995) Aggregate testing for the evaluation of Johne's disease herd status. AVJ 73: 16-19.

- Nérette P et al. (2005) Estimation of the repeatability and reproducibility of three diagnostic tests for infectious salmon anaemia virus. Journal of Fish Diseases 28: 101-110.

- Jafarzadeh et al (2004) The sensitivities and specificities of total plasma protein and plasma fibrinogen for the diagnosis of traumatic reticuloperitonitis in cattle. Prev Vet Med 65: 1-7.

- Pooled prevalence calculator http://www.ausvet.com.au/pprev/content.php?page=home