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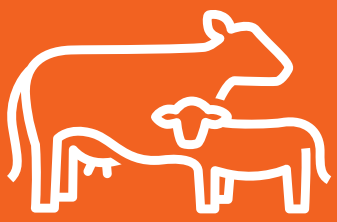

BVDV

Guidelines for the investigation and control of BVDV
(Bovine Viral Diarrhoea Virus or Bovine Pestivirus)
in beef and dairy herds and feedlots

3RD EDITION DECEMBER 2011

ZOETIS (FORMERLY PFIZER ANIMAL HEALTH)
HAS SPONSORED THE ESTABLISHMENT OF
THE BVDV TECHNICAL ADVISORY GROUP

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BVDV Technical Advisory Group

Michael McGowan
Professor of Livestock Medicine
University of Queensland, School of Veterinary Science, Gatton QLD

Peter Kirkland
Principal Research Scientist, Officer in Charge
Virology Laboratory, Elizabeth Macarthur Agriculture Institute, Menangle NSW

Rod Howard
Private Veterinary Practitioner
Kilcoy Veterinary Clinic, Kilcoy QLD

John Morton
Veterinary Epidemiological Consultant
Geelong VIC

Peter Younis
Dairy Veterinary Practitioner
Timboon Veterinary Group, Timboon VIC

Enoch Bergman
Veterinary Practitioner
Swans Veterinary Services, Esperance WA

Paul Cusack
Consultant Veterinarian and Nutritionist
Australian Livestock Production Services, Cowra NSW

Executive Summary

These guidelines have been developed by the BVDV Technical Advisory Group – a group of veterinary researchers and practising veterinarians who provide services to dairy and beef herds and feedlots across Australia. Zoetis Australia kindly provided the funding for this project. The primary objective of these guidelines is to improve decision-making on investigation and control of BVDV infection in cattle.

The guidelines focus on three common questions confronting cattle veterinarians and their clients, namely:

- Could BVDV infection be contributing to the problems in this herd or management group?
- How can BVDV infection be prevented or controlled in this herd or management group?
- How can the impact of BVDV infection be controlled in this feedlot?

The critical steps to address in each question are highlighted in the flow charts, and there are links to detailed supporting information.

QUESTION I

Could BVDV infection be contributing to the problems in this herd or management group?

Step 1: Consider the evidence

Look at the **clinical history** of the herd or management group

- Undertake **clinical examinations and diagnostic testing for BVDV.** Include investigation of the likely contribution of other potential infectious and non- infectious causes of reproductive performance
- To help interpret the results, consider the evidence that may approximate when BVDV infection occurred in the herd or group. If a PI animal has been detected, determine its age – its dam is likely to have become infected 5-8 months prior to the birth of the PI animal

Outcome

- If you conclude that BVDV is **LIKELY** to be contributing to the problems detected in this herd or management group, go to **Step 2**
- If you conclude that BVDV is **UNLIKELY** to be contributing to the problems detected in this herd or management group but would like to know how to decrease the risk of BVDV infection, go to **Question II**

Step 2: Determine the proportion of heifers or cows in this herd that are likely to be susceptible (i.e. not immune) to BVDV infection during the next mating period

- Do a **serological profile** of this herd (you may have already done this as part of your initial investigation)
- Decide whether this herd or individual management groups within the herd will have a high or low proportion of animals susceptible during the next mating period

Outcome

- High proportion of susceptible animals anticipated during the next mating period
- Low proportion of susceptible animals anticipated during the next mating period

Step 3: Assess the risk of exposure to BVDV infection during the next mating period

- Look at all the possible ways that BVDV could be introduced to and/or transmitted in this herd or management group
- Decide whether this herd or management group will have a low or high risk of exposure to BVDV during the next mating period

Outcome

Assess the anticipated status of this herd/management group during the next mating period. The herd or management group will fall into one of four categories:

1. High % of heifers or cows susceptible/high risk of exposure
2. High % of heifers or cows susceptible/low risk of exposure
3. Low % of heifers or cows susceptible/high risk of exposure
4. Low % of heifers or cows susceptible/low risk of exposure

Step 4: Options for controlling BVDV in this herd or management group

In discussion with the herd manager, decide which of the following control options or combination of control options best suits this herd or management group:

- Vaccination
- Partial vaccination
- Autovaccination
- Removal of PI animals
- Biosecurity measures
- No specific management to control BVDV

QUESTION II

How can BVDV infection be prevented or controlled in this herd or management group?

Step 1: Determine the proportion of heifers or cows in this herd that are likely to be susceptible (i.e. not immune) to BVDV infection during the next mating period

- Do a **serological profile** of this herd (you may have already done this as part of your investigation)
- Decide whether this herd or the individual management groups within the herd will have a high or low proportion of animals susceptible during the next mating period

Outcome

- High proportion of susceptible animals anticipated during the next mating period
- Low proportion of susceptible animals anticipated during the next mating period

Step 2: Assess the risk of exposure to BVDV infection during the next mating period

- Look at all the possible ways that BVDV could be introduced to and/or transmitted in this herd or management group
- Decide whether this herd or management group will have a low or high risk of exposure to BVDV during the next mating period

Outcome

Assess the anticipated status of this herd/management group during the next mating period. The herd or management group will fall into one of four categories:

1. High % of heifers or cows susceptible/high risk of exposure
2. High % of heifers or cows susceptible/low risk of exposure
3. Low % of heifers or cows susceptible/high risk of exposure
4. Low % of heifers or cows susceptible/low risk of exposure

Step 3: Options for controlling BVDV in this herd or management group

In discussion with the herd manager, decide which of the following control options or combination of control options best suits this herd or management group:

- Vaccination
- Partial vaccination
- Autovaccination
- Removal of PI animals
- Biosecurity measures
- No specific management to control BVDV

QUESTION III

How can the impact of BVDV infection be managed in this feedlot?

The bovine respiratory disease (BRD) complex is the most significant disease problem in feedlot cattle. BVDV may play an important role in this disease complex, both as a predisposing factor for infection with other viruses and bacteria and as a potential primary pathogen.

American studies have shown that the presence of a PI animal in a pen of feedlot cattle will increase respiratory disease incidence, mortality rates, and drug costs in pen mates and cattle in adjacent pens. Further, the presence of PI animals in the same pen or adjoining pens has been shown to have negative effects on average daily gain and feed conversion. Transmission of the virus can occur prior to arrival at the feedlot, during mustering, yarding, marketing and transport. Although many animals in some groups of cattle may be immune to BVDV on arrival at the feedlot, in other groups many cattle will be susceptible. The immunosuppressive effects of BVDV can be prolonged and so infection immediately prior to entry to the feedlot may increase the risk of infectious disease in these cattle.

Managing BVDV in feedlots can be done using **vaccination** and/or **removal of PI animals.**

What is BVDV?

Bovine virus diarrhoea virus (BVDV) belongs to the genus *Pestivirus* and is considered worldwide to be one of the most important viral pathogens of cattle. The *Pestivirus* genus also contains the viruses that cause border disease in sheep and classical swine fever in pigs. Some interspecies transfer of BVDV can occur, with infections recorded in sheep, a range of other ruminants, camelids, and sometimes in pigs. Transfer of viruses from sheep to cattle is uncommon but can occur. The acronym BVDV can be misleading as this virus causes a variety of clinical entities, the most significant of which is reproductive disease. Two genotypes of BVDV, Type 1 and Type 2, have been recognised but only the Type 1 variant is found in Australia. The clinical signs due to infection with either genotype are typically similar but there can be a more severe disease presentation with some Type 2 strains.

The terms cytopathic and non-cytopathic biotypes (classified according to the ability of the viruses to produce visible pathological changes in *in-vitro* cultured cells) are of little diagnostic significance. Most disease presentations are the result of infection of animals with non-cytopathogenic viruses. Cytopathogenic viruses play a role in the terminal disease of persistently infected animals (see below) that die from mucosal disease, but this syndrome represents only a small proportion of the clinical outcomes of BVDV infection.

The biology of BVDV infections in cattle – transient and persistent infections

Infection of cattle should be considered in two distinct categories – prenatal infections (from ovulation through to calving) and postnatal infections (from birth onwards). After birth, animals may be protected from infection either by colostral antibodies (protection lasting for up to 4 or 5 months) or by immunity, which develops subsequent to infection or vaccination. Immunity that follows natural infection is long lasting, probably for the life of the animal.

Transient or acute infection

When animals that are susceptible to infection become exposed to BVDV, they undergo a transient (sometimes called acute) infection; that is, the infection lasts for a short period and the virus is cleared by the immune system. There is a short incubation period of 3-4 days followed by a period of viraemia (virus circulating in the blood) of about 7-10 days. Cattle produce detectable antibodies (seroconvert) from about 13-19 days after exposure and progressively eliminate the infection. Virus is shed by the transiently infected animal for about 10 days after initial infection. With the Type 1 viruses found in Australia, virus may be detectable in excretions and body fluids during the transient infection, but generally the concentration of virus is very low and these discharges do not result in spread of the virus to other animals. With some Type 2 strains, the levels of virus excreted may be much higher and spread to other cattle is more likely.

Persistent infection

When the foetus is infected between about 30-90 days of gestation and survives the infection to term, the developing immune system recognises the virus as 'self'. As a result, the foetus will be infected with the virus for life ('persistently infected' or PI) and does not produce antibodies to the virus. This leads to the birth of a seronegative calf that is immunotolerant to BVDV. Foetal infection between 90 and 125 days of gestation can result in persistent infection, although development of the immune response during this time reduces the proportion of calves that become PI. When a foetus is infected after about 125 days of gestation, it is able to mount an immune response to the virus and will be born immune to BVDV and seropositive.

The prevalence of PI calves in a herd will depend on the proportion of seronegative animals exposed and on the timing of that exposure. In some outbreaks, up to 50% of calves in a herd or group have been found to be PI but in the national herd, the overall prevalence of PI cattle is estimated to be between 0.5 and 1.0%.

Transmission of BVDV

Persistently infected animals excrete large amounts of virus in body fluids and discharges (nasal and oral secretions, aerosols, tears, milk, semen, urine and faeces) throughout their life, and are the main reservoir of BVDV in a herd. The virus can survive in these discharges in the environment for short periods, perhaps a few hours to days depending on exposure to sunlight, moisture levels and environmental temperature. Hot dry conditions rapidly inactivate the virus. For spread to occur, a susceptible animal can be infected from direct contact with a PI animal or from contact with infected discharges. The presence and movements of PI animals in a herd are the keys to the spread of BVDV. Infection rates in a herd will depend on the number of PI animals present, the level of herd immunity and the degree of contact between animals. Management practices that result in close contact (e.g. mustering, yarding or trucking) can accelerate transmission in a mob. With close contact in yards, up to 60% of susceptible animals have become infected within 24 hours. On pasture, infection rates vary with stocking rate but can be between 0.1 and 0.5% of susceptible animals per day.

If a BVDV-infected cow aborts an infected foetus, the foetus and placenta may also serve as a source of BVDV for a short time and result in spread of the virus.

The low levels of virus shed by animals that are transiently infected with the Type 1 strains of BVDV found in Australia rarely results in spread to other cattle. However limited spread via close contact with reproductive discharges from transiently infected females has been reported.

Transient, acute infection of non-breeding animals

Transient infections of non-breeding animals are usually undetected in Australia in non-intensive farming systems. Infections are usually sub-clinical or are of short duration and very mild. Fever and diarrhoea are not common, despite the name of the virus. However, transient infections in intensively managed cattle (e.g. cattle in feedlots or calf raising units) can result in significant disease such as bovine respiratory disease (BRD) where BVDV can contribute to infectious bronchopneumonia both directly and indirectly. BVDV contributes indirectly by inducing immunosuppression, which increases the susceptibility of animals to infection from a range of pathogens. This immunosuppression can last up to 2 months beyond the initial infection.

Some of the more virulent strains of Type 2 BVDV have caused severe disease and fatalities in the UK and USA during transient infection, especially as a result of a rare haemorrhagic disease syndrome.

Infection of breeding animals

The clinical outcome of infection in breeding females is determined by the stage of the reproductive cycle at which infection occurs. A wide range of effects can be observed, from reduced conception rates following infection around the time of mating/AI; embryonic death, abortion, stillbirth, the birth of weak non-viable calves or the birth of PI calves after infection in the first trimester; through to congenital defects after infection during the second trimester. The range of clinical outcomes relative to the stage of the reproductive cycle and the development of the foetal immune system when infection occurs are summarised in Table 1.

Table 1. The clinical outcome of infection is determined by the stage of the reproductive cycle/gestation when infection occurs

<table>
<tr><th colspan="5">Stage when infected</th></tr>
<tr><th>Around time of mating/AI</th><th>First trimester</th><th colspan="2">Second trimester</th><th>Third trimester</th></tr>
<tr><td>Disrupts ovulation and fertilisation
Early embryonic death</td><td>Production of PI calves
Late embryonic death, abortions, stillbirths</td><td colspan="2">Abortions
Late delivery of unviable or abnormal calves at full-term
Central nervous system effects
Eye defects</td><td rowspan="2">No reported problems associated with infection during this period</td></tr>
<tr><td colspan="2">Reduces conception and pregnancy rates
Increases returns to service
Delays conception date</td><td colspan="2">Reduction in number of calves born and viability of calves</td></tr>
<tr><td colspan="2"> 
Normal foetus (top)
Non viable BVDV infected foetus (below)</td><td> 
Aborted foetus</td><td> 
BVDV infected brain</td><td>  </td></tr>
</table>

Disease in persistently infected animals

PI animals (the outcome of infection primarily between about 30 and 90 days of gestation) that survived to term may live for varying periods of time after birth. They often do poorly compared to other calves, and are frequently smaller than expected at birth. PI animals are often 'immunological cripples', developing severe, non-responsive manifestations of common diseases (e.g. ringworm, *Dermatophilus* infection) due to the immunosuppressive effects of BVDV. They can also act as reservoirs for other infectious diseases. PI animals will often suffer periods of disease, make a brief recovery then relapse. The majority of Australian PI animals that die do not show signs of mucosal disease, but rather a variety of infections that follow severe immunosuppression and lymphoid depletion. Mucosal disease, characterised by ulceration of the buccal cavity and alimentary tract, is only observed in PI animals and occurs after 'superinfection' with a cytopathogenic strain of BVDV that has arisen as a mutant form of the persisting virus. This mutant strain need only arise in one PI animal in a herd and will rapidly spread to other PI animals in the herd, due to their immune tolerance to the same virus strain, resulting in the relatively sudden death of clusters of PI animals.

It is estimated that about half of all PI cattle die within the first 12 months of life, and about half or more of the remaining PI animals die in the next 12 months. However, sometimes a PI animal will survive for a number of years. Female PI animals can breed successfully but their progeny are always PI.

What diagnostic tests are available to detect BVDV antibodies and what do they tell you?

- Vaccination history must be known to properly interpret results.
- Although the scoring systems for these tests have been standardised nationally, reading of the results is subjective; results may therefore vary slightly from laboratory to laboratory but the herd profile should not change significantly.

Test	Interpretation	Advantages/Disadvantages
AGID	Used to measure seroprevalence and to detect recent infection (especially within last 9 months) Test will detect antibody (Ab) from at least several years before Ab reaction measured and quantified: negative = susceptible animal 1 or 2 (weekly positive/positive) = exposure to BVDV less likely to have happened within the last 12 months ≥3 (strongly or very strongly positive) = recent infection, usually in the last 3-9 months **Samples from pregnant females that yield this result indicate the female may be carrying a PI foetus**	• Moderately high sensitivity (in the period of about 2 years postinfection); high specificity • Quick test, sample quality less important than VNT • Can detect Ab 2 weeks post-infection with maximum reaction usually about 5-12 weeks post-infection • Will not usually detect Ab post-vaccination • Vaccinated cattle will still develop AGID titres if naturally exposed to BVDV. This can be used to monitor if BVDV is still circulating in a herd that is vaccinated
Virus neutralisation test (VNT)	Used to measure seroprevalence; difficult to predict time of infection • Most very high titres (>1280) indicate infection in last 9-12 months • Ab titre measured as a reciprocal of serum dilution: ≤10 = Negative 20, 40, 80, 160, 320 etc. to >5120 = positive	• Detects Ab 2 weeks post-infection but titres rise for up to 9 months – difficult to interpret 'rising' titres on positive paired samples • Detects vaccine Ab and good for comparison of titres in sequential samples from vaccinates • Good test for detection of low levels of Ab; need very good quality samples • Sensitivity and Specificity of test varies depending on antigenic similarity between reference strain used in test and herd strain

Test	Interpretation	Advantages/Disadvantages
Antibody ELISA	Used to measure seroprevalence by detecting Ab. May be done on blood or milk samples	As for Virus Neutralisation Test ELISA tests typically detect antibodies sooner after infection/vaccination than VNTs TEGO blood collection devices allow blood collection by producers at their convenience. Samples do not require refrigeration. PI testing can be done on the same samples if necessary

Test	Interpretation	Advantages/Disadvantages
BVDV Antibody ELISA for Milk	May be used to measure the BVDV antibody level in milk from individual animals, or more commonly in a sample of milk taken from the vat at the completion of milking. There is a correlation between this latter measurement and the proportion of seropositive animals in the milking herd, and the concentration of antibodies in seropositive animals The results of this test are expressed as a S/P ratio (Sample/Positive: Control ratio) • Very low values (approximately 0.25 or less) are indicative of very low seroprevalence in the milking group • Very high values (approximately >1.0) in an unvaccinated herd are indicative of high seroprevalence in the milking group, and may suggest there are many animals that have been infected relatively recently, or sometimes that there may be one or more PI animals in the herd • S/P values between 0.25 and 1.0 include herds with a wide range of seroprevalence which require further investigation (e.g blood sampling for an AGID serological profile) before recommendations can be made about BVDV management Very large changes in the S/P ratio indicate changes in the BVDV status of the herd, which require review of the BVDV management of the herd. For example, a significant drop in the SP ratio may indicate a herd is more susceptible. A significant increase in S/P ratio may indicate the recent introduction of a PI	• Recent vaccination can result in a significant increase in the S/P ratio • Care should be taken that vat samples are representative of the milking group • Easy to collect, inexpensive test. Facilitates regular monitoring of the BVDV status of the milking herd • Doesn't assess the other management groups in the herd i.e. dry cows, heifers, bulls

What are the tests for identifying Persistently Infected animals?

- PI animals will have an ongoing negative or weak antibody reaction and a positive test for antigen.
- Care should be taken in interpreting results from testing blood samples from animals less than six months of age as colostral antibodies may reduce the sensitivity of the antigen capture ELISA test in detecting PI animals. The preferred samples for testing calves under 6months of age to detect PI animals are ear notch (skin tissue) or hair.

Test	Sample	Cost/sensitivity/ turnaround time	Advantages/disadvantages
Antigen capture ELISA	Leukocytes Blood clot Serum Plasma Bulk Tank Milk Tissues Skin e.g. ear notch Hair, including the roots	Relatively low cost/ high sensitivity Turnaround: 1-2 days (serum, plasma, skin) 2-3 days (leukocytes, tissues)	• Can be used for whole herd/group testing and for detecting individual PI animals • Infrequently detects transiently infected animals if testing blood or serum but may occasionally detect transient infections with skin as the sample • Skin testing (Ear notch testing) The advantage of using a skin sample is that colostral Abs do not interfere with the test • Must re-test test positive animals 3 weeks later to confirm persistent infection • Cost of skin testing is less than blood testing because blood samples have to be spun down and serum separated off • Ensure cross contamination of samples does not occur, and samples are appropriately identified for individual animals

Test	Sample	Cost/sensitivity/ turnaround time	Advantages/disadvantages
Polymerase chain reaction (PCR)	Serum Plasma Tissues Tank Milk	Moderate cost/very high sensitivity 2-3 days turnaround	• Not most cost-effective method of determining individual PI animals • Good for screening of pooled samples from whole herd/group bleeds. If a pool tests positive, the individual samples are re-tested to identify infected individual(s) • Must re-test suspected PI animals 3 weeks later to confirm persistent infection (rather than transient infection) • There is potential for cross-contamination • In tank milk, a negative test provides confidence of no exposure on up to 400 milkers Positive pools suggest presence of a PI and require individual screening to find these animals.
Virus isolation (VI)	Serum Blood Tissues	High cost/high sensitivity 1-3 weeks turnaround	• Not preferred test for routine herd screening due to cost and turnaround time • Must re-test suspected PI animals 3 weeks later to confirm persistent infection (rather than transient)
Immunohisto-chemistry (IHC)	Skin Tissues	High cost/high sensitivity 3-5 days turnaround	• Not preferred test for routine herd screening due to cost and turnaround time • Useful research tool • Able to detect small amounts of BVDV infection. May be used to determine if transient infection with BVDV has been an underlying cause of disease outbreaks, especially in feedlot cattle

Is BVDV likely to have contributed to the reduced performance in this herd or management group?

Assess the history of the herd over the last 18 months to 2 years. BVDV infection is not unusual in Australian herds and can cause the problems listed below. BVDV should be considered a potential contributor to reduced herd/group performance if the following problems are occurring:

- **Reduced reproductive performance**
  - lower than expected conception rate and/or delayed time to conception, reduced pregnancy rate, abortions, spread-out calving pattern
- **Increased calf morbidity and mortality**
  - unexpectedly high incidence of stillbirths, congenital defects, mortality in young calves, weak, stunted and 'poor doing' calves
- **Reduced weaner/yearling growth and health**
  - ill thrift and deaths in weaners and yearlings
- **Mucosal disease**
  - clinical diagnosis of mucosal disease
- **Post-mortem results**
  - evidence of changes consistent with BVDV infection (in foetuses and calves: cerebellar hypoplasia; in weaners, yearlings and adults: mucosal disease)
- **Increased incidence of infectious respiratory or enteric diseases**
  - unexpectedly high incidence of diseases such as bovine respiratory disease (BRD) or calf scours.

How is the contribution of BVDV to reduced reproductive performance in a herd or management group assessed?

The causes of reduced reproductive performance are multifactorial and thus it is important to undertake a systematic investigation to assess the likely contribution of potential known non-infectious and infectious causes of reduced performance. In dairy herds for example, there are many management factors that are important contributors to reduced herd reproductive performance. Readers working with dairy herds are advised to consult the InCalf book (Dairy Australia, 2003) and tools (www.incalf.com.au) for further information.

Assessing the contribution of BVDV to reduced reproductive performance

Sampling and test requirements vary with the time at which loss is identified. Examples include:

1. **Reduced reproductive performance**

   - usually identified by a reduced pregnancy rate at pregnancy diagnosis. If BVDV infection has contributed, infection will have occurred one to several months before the event is observed. Collect serum samples from representative *affected* animals (approximately 10 animals) and test for antibodies using the **BVDV AGID test**. Determine the proportion of positive animals and whether there is evidence of recent infection based on the strength of AGID reactions. It is important to note that collection of paired samples to demonstrate seroconversion is not usually a useful option here. If BVDV is a contributor, the infection occurred one to several months ago and any seroconversions associated with the loss would have already taken place. However, paired serology can be useful when samples are collected from at-risk females prior to commencement of mating and again at the time of early pregnancy diagnosis.

2. **Abortions and reduced calving rate**

   - may be evidence of abortion or just failure to calve.
     If there is no foetal material available, sample as (1) above.
     If a foetus is available collect:
     - Pericardial fluid to test for IgG level and BVDV antibody
     - Fresh lung and spleen to test for BVDV antigen using antigen-capture ELISA or BVDV virus using virus isolation or PCR
     - Fixed tissues for histopathology.

3. **Stillbirths and reduced viability of calves**

   - if BVDV is contributing to these problems, calves will have been infected at some stage during gestation. Collect samples as in (2) above and test for both BVDV antigen or virus and BVDV antibodies. (Remember that the ability to detect antigen may be compromised in calves < 5 months old due to the possibility of residual colostral antibodies. Testing of skin biopsy or hair root samples may overcome this problem).

4. **Weaner and yearling disease**

   - some or all of these will be persistently infected animals if BVDV is contributing to the problems. These animals were most likely to have been infected with BVDV between about 30 and 90 days of gestation. Test for BVDV antigen in the blood, skin biopsy or hair sample if the animal is alive, or from the spleen/lung if the animal is dead. Also, fix tissues for histopathology.

How is a serological profile obtained and what does it tell you?

The AGID test is recommended for herd/management group serological profiles as it also allows an assessment of whether the BVDV infection is recent or occurred a long time ago. Other serological tests, such as the virus neutralisation test or antibody ELISA, can be used to demonstrate that animals have been infected with BVDV but it is usually not possible to estimate whether the infection is recent or occurred a long time ago with these two tests.

How is a serological profile obtained?

When obtaining a serological profile, the structure of the herd must be taken into account. Review the herd structure considering the number of groups and how these groups are segregated by husbandry management and age.

- **If animals in a group are the same age**
  - collect serum from an appropriate number of randomly selected animals from each management group in the herd.
- **If there are multiple ages in the group**
  - sample an appropriate number of animals from each age category (e.g. first calvers, mature cows). The optimal group profile will include samples from heifers to be joined, joined heifers, first calvers and mature cows.
- **If there are multiple groups of the same age**
  - each group should be sampled if they have been managed discretely during the current (or previous) breeding season.

The precision of the serological profile will depend on how many animals are tested. Consult Table 2 to determine the precision you will achieve with different numbers of animals tested.

What does an AGID test serological profile tell you?

The AGID serological profile indicates:

- The seroprevalence of BVDV antibodies in the herd or management group; that is, what proportion of animals have been exposed to BVDV.
- An estimate of how recently the exposure may have occurred within the herd or management group.

Estimating the percentage of susceptible cattle in a herd or management group

The percentage of tested animals that are seronegative enables you to estimate the percentage of animals in the herd/group that are susceptible.

The percentage of randomly selected animals that are seronegative may differ from the percentage of animals in the herd/group that are seronegative. It is therefore important to consider the confidence interval for the estimate when interpreting these results. If you sample a larger number of representative animals, the confidence interval will be narrower and so your estimate of the percentage of animals in the group/herd that are susceptible will be more precise.

Table 2 shows the 90% confidence intervals for various numbers of animals tested and for the various percentages that test negative. For example, from the table, if you test 20 animals and 6 (30%) are seronegative, you can be reasonably sure that the percentage of seronegative animals in the herd/group is between 14 and 51%. And if you test 30 animals and they all test negative, you can be reasonably sure that the percentage of seronegative animals in the herd/group is at least 90%.

Table 2. Determining the precision of the serological profile with different numbers of animals tested

Number of animals tested			
% of animals tested that were seronegative	10	20	30
(Likely % of animals in herd/group that are seronegative)			
0 (i.e. all tested positive)	0-26	0-14	0-10
30	9-61	14-51	17-47
50	22-78	30-70	34-66
70	39-91	49-86	53-83
100 (i.e. all tested negative)	74-100	86-100	90-100

If the percentage of seronegative animals in the herd or group is likely to be less than 25%, you can assume that the percentage of susceptible animals present in the herd or group is low. If the percentage of seronegative animals is likely to be above 25%, you can assume that the percentage of susceptible animals present in the herd or group is high. Use the 90% confidence limits for this assessment. For example, if you tested 20 animals and 10 (50%) were seronegative, the likely percentage of animals in the herd that are seronegative is between 30 and 70%; that is, at least 30% are seronegative so this should be considered a high percentage susceptible.

Is the infection recent?

The strength of the AGID reaction is quantified on a scale of 1 (has been infected with BVDV at some time in the past) to 3 and >3 (has been recently infected with BVDV). A negative result (presumed to be a susceptible animal) is reported as a negative. As a guide:

- **Animals testing ≥3**
  – these animals are likely to have been exposed to BVDV infection in the past 3-9 months. Samples from pregnant females that yield this result indicate the female may be carrying a PI foetus.
- **Most animals tested have reactions of 1 or 2**
  – exposure to BVDV in the last 12 months is unlikely in this herd/management group but the infection has been widespread in the past. However, it is possible in young cattle aged 6-12 months that the infection is recent and the antibody levels are just rising. However, generally it is unusual to have only reactions of 1 or 2 in a group where there is active spread.

What are the risk factors for BVDV exposure and how is risk of exposure assessed?

Risk of introduction of BVDV into the herd or management group with new cattle

The most important means by which BVDV is introduced to a herd or management group is by the inadvertent addition of PI animals or pregnant females carrying a PI foetus. Less commonly, transiently infected females and bulls can introduce infection to a herd or management group. Although the amount of virus shed by transiently infected replacement females or bulls is much less than that from PI animals, it has been shown that BVDV can be introduced this way. To assess the risk of virus being introduced with new animals, examine the history of introduction of replacement females and/or bulls and mixing of cattle from different herds/groups:

- Consider introductions/mixing during agistment or mustering of cattle, or as a result of fence breakthroughs.
- Consider introductions or mixing events that have occurred in the past 2 years (at least).
- Consider likely BVDV status of herds/groups from which introduced cattle have been sourced.

Short-term transmission by PI animals

Because PI animals shed very large amounts of virus in all body secretions, even relatively short periods of contact (1 hour) can result in transmission of infection. To assess the risk of this occurring, look at the history of:

- Taking cattle to a sale and then returning some of these cattle to the herd/group.
- Taking cattle to an agricultural show.
- Over-the-fence contact with neighbouring cattle – it is also important to be aware of the management practices of neighbouring properties, e.g. closed herd or cattle dealer.

Risk of introduction of BVDV via contaminated semen, embryos, husbandry/surgical equipment, biting flies, cattle trailers and trucks

The risk of introduction by these routes is relatively minor but has been reported. To assess this risk, ask questions such as:

- Is custom-collected semen introduced and used on the farm?
- Are cattle trucked using farm-based transport or outside transport? What is the level of hygiene of outside transport?
- What hygiene practises are routinely used for husbandry and surgical equipment?

Role of other species

Although uncommon, sheep, goats and alpacas can be infected with BVDV and may rarely introduce the virus into a herd.

Risk of transmitting BVDV within a herd/group

BVDV is spread primarily via contact with aerosols, bodily fluids and faeces from PI animals. Thus any situation that results in close contact between cattle could result in transmission.

Assess:

- Frequency of temporary high-stocking situations associated with yarding to carry out various management and husbandry procedures (e.g. weaning); transportation between or within properties; supplementary feeding and fixed watering sites.
- Likelihood of spreading the virus during routine husbandry and management procedures, especially where yarding is involved, such as vaccination or pregnancy testing (are cattle yarded overnight prior to testing?).
- Stocking density of the herd/group in the paddock under normal conditions.

What do these categories mean?

These categories describe herd/group status relative to the risk of BVDV exposure originating from an *external* source (i.e. from outside the herd or management group).

High % of susceptible animals/high risk of exposure

This category of herd/group is at risk of BVDV exposure and the consequences of BVDV could be significant due to the high proportion of susceptible animals.

High % of susceptible animals/low risk of exposure

Although the likelihood of exposure is low in this category, the consequences of BVDV could be significant due to the high proportion of susceptible animals. This category applies to about 10% of herds in Australia that are free of infection because of geographical isolation, application of herd biosecurity measures and/or absence of any PI cattle in the herd or in surrounding properties. These herds should be regularly monitored to ensure that the risk of exposure does not increase.

Low % of susceptible animals/high risk of exposure

Although the likelihood of exposure to BVDV is high in this category, because only a low proportion of the herd/management group are susceptible to infection, the impact of infection on the herd/management group's performance is likely to be low. However, if some susceptible females become infected between 30 and 90 days of gestation, there is a high probability that any resulting calves will be persistently infected, and the cycle of infection in the herd or group will be maintained.

Low % of susceptible animals/low risk of exposure

In the absence of vaccination, this is a herd/group in which there has previously been widespread infection but now the external source of infection is no longer present.

OPTIONS FOR CONTROLLING BVDV
Vaccination

Important considerations

Vaccination becomes more appropriate as the proportion of susceptible cattle in the herd/group increases and as the risk of exposure increases.

If you are planning to conduct an artificial breeding program, strong consideration should be given to vaccinating breeding females prior to conducting the program.

What are the benefits of vaccination?

- Properly conducted, vaccination of a herd/management group will result in a high proportion of the females being immune to infection, which minimises the likelihood of losses if the herd/group is exposed to BVDV.

What are the disadvantages of vaccination?

- Vaccination is not 100% effective. There will still be a proportion of susceptible animals in the herd/group despite vaccination so adequate biosecurity and monitoring procedures are still required to prevent re-introduction and transmission of the virus and subsequent infection of susceptible animals. It may also be advisable to consider testing all the cattle in the herd/group to identify and cull PI animals. PI breeding females will produce PI calves even if vaccinated.
- Vaccination must be maintained to ensure long-term protection. If vaccination of a herd following BVDV infection is maintained for several years, the herd is likely to become free of infection; it then follows that in the absence of vaccination, this herd will experience an increase in the proportion of susceptible animals over time unless re-exposed to BVDV from an external source.

What is the vaccination protocol for a herd or management group?

- **Whole herd/group vaccination program** – in the first year each breeding female should be vaccinated twice with the second vaccination occurring at least 4 weeks before commencement of mating. Thereafter, females should be vaccinated once a year, preferably 4 weeks prior to the start of mating.
- **Replacement heifer vaccination program** – heifers should be vaccinated twice, with the second vaccination occurring 2–4 weeks prior to the commencement of mating.
- **Previously unvaccinated cows and bulls** – will require a primary course of vaccination consisting of two doses of vaccine, with an interval of 4 weeks – 6 months between doses. The primary course of vaccination should preferably be completed 2-4 weeks prior to joining/insemination.
- **Pregnant cows** – pregnant cows can now be vaccinated as part of routine herd health immunisation program. If a cow is pregnant with a PI calf, vaccination will have no effect on the status of the PI calf.

Active immunisation with Pestigard® is an effective and economical solution to controlling BVDV

	Heifers		Cows*	1st Season or New Bulls		Bulls*
Schedule	**Primary Course**		**Annual Booster**	**Primary Course**		**Annual Booster**
Timing	1st Dose: 6-8 weeks pre-joining	2nd Dose: 2-4 weeks pre-joining	2-4 weeks pre-joining	1st Dose: 6-8 weeks pre-joining	2nd Dose: 2-4 weeks pre-joining	2-4 weeks pre-joining
Farm Management Flexibility	1st Dose may be given up to 6-months pre-joining		May be given at pregnancy testing or branding. Pregnant cows can be vaccinated†	1st Dose may be given up to 6-months pre-joining		
Pestigard®	✓	✓	✓	✓	✓	✓

Protective immunity is expected to develop within 14 days of the second dose.

*Previously unvaccinated cows and bulls will require a primary course of vaccination consisting of two doses of vaccine, with an interval of 4 weeks - 6 months between doses. The primary course of vaccinations should preferably be completed 2-4 weeks prior to joining/insemination.

† If a cow is pregnant with a PI calf, vaccination will have no effect on the status of the PI calf.

- The vaccine should be stored between 2 and 8°C and protected from light.
- When ready to use the vaccine, it must be *gently* mixed (vigorous shaking may cause the product to foam) and kept thoroughly mixed during use.
- The dose of vaccine on all occasions is 2 mL. The vaccine should be injected subcutaneously. All the vaccine must be used within 30 days of opening.

What is the cost of implementing vaccination in your operation?

The costs of implementing a vaccination program can be calculated by summing the following costs:

- **Cost of vaccine per head** – in the first year of the program two doses per head will be required and, in subsequent years, one dose per head. All replacement heifers will need two doses.
- **Costs of mustering cattle**.
- **Cost of conducting vaccination** – vaccination depends on the quality of the handling facility and on the skill of the personnel conducting vaccination.

Partial vaccination

(Vaccination of part of the herd or management group that is more likely than the rest to become infected and experience losses due to BVDV infection)

Important considerations

This option is commonly implemented to reduce the likelihood of BVDV infection in replacement heifers. Often, due to the fact that replacement heifers are reared in isolation to the adult herd, there may be a high proportion of susceptible animals in this group.

Analysis of the results of serological profiling of the heifer and cow herds/groups and consideration of the timing of introduction of the replacement heifers to the cow herd relative to the commencement of mating will enable assessment of the likely benefits of implementing this option.

What are the advantages of partial vaccination?

- The major advantage of this option is the reduced number of vaccine doses required for the herd.

What are the disadvantages of partial vaccination?

- Infection in the unvaccinated animals may result in losses and maintenance of infection in the herd/group.

What is the protocol for vaccinating heifers only in a herd or management group?

- Heifers should be vaccinated 4 weeks to 6 months apart, with the second vaccination occurring 4 weeks prior to commencement of mating. If the heifers are going to be maintained in isolation from the cow herd until after calving, it may be beneficial to vaccinate them again prior to entry into the cow herd.

Autovaccination

(Controlled, natural transmission of infection using PI animals)

Important considerations

If this approach to inducing immunity is to be used, it is critical that autovaccinator cattle (i.e. the animals you suspect are PI animals) are tested and confirmed to be PI animals. Further, the PI animals must be clearly identified so that they are not inadvertently mixed with cattle in the early stages of pregnancy.

The PI autovaccinator cattle should be placed in a small yard with the replacement heifers each year at least 16 weeks prior to the start of mating and kept separate from breeding females at all other times.

As PI cattle have a significantly shorter life expectancy than normal cattle, if the autovaccinator cattle die and there are no other PI cattle in the herd, the herd will progressively become more susceptible to infection over time.

What are the advantages of autovaccination?

- Yarding susceptible cattle with a PI animal for a period of several days should result in a high proportion (>80%) becoming infected and subsequently developing long-lasting immunity. To increase the likelihood of exposure of the susceptible cattle to the PI animal(s), the cattle should be fed and watered at a single point in the yard, and regularly moved around in the yard.

What are the disadvantages of autovaccination?

- You cannot be guaranteed that all cattle in the group exposed to the PI animal will become infected and hence immune because of issues such as the number of animals in the group and the behaviour of the PI animal (it may be a 'shy' animal). Most studies that have induced infection using this method have exposed a relatively small numbers of heifers (<30) to a single PI. There is a lack of information on how long much larger mobs of heifers should be exposed to a single PI animal to ensure the majority become infected. A possible way to address this problem would be to draft large heifer mobs into several smaller groups in the cattle yards, and then rotate the PI between pens of heifers every couple of days for a period of about 2 weeks.

- Exposure to infection using this method can be variable and some susceptible cattle may still be present in herds/management groups. Accordingly, the seroprevalence of BVDV antibodies in exposed groups should be assessed.

- If exposure to PI animals occurs during weaning, there is a risk of increased infectious disease among these weaners due to the immunosuppression associated with transient BVDV infection.

Removing PI animals from the herd or management group

Important considerations

If this option is implemented then farmers must recognise that, over a period of several years, the proportion of susceptible cattle in their herd/group will increase substantially. If the risk of exposure to infection continues to be high then options to enhance the immunity of the herd/group (e.g. vaccination of the herd/group) and/or reduce the risk of exposure to infection (e.g. implement biosecurity measures) should be strongly considered.

For maximum benefit, PI animals need to be removed prior to the subsequent joining to prevent exposure of seronegative pregnant females and their unborn calves.

If a producer aims to eradicate BVDV from their herd/management group, several rounds of herd/group testing may need to be done, followed by ongoing monitoring, to verify freedom from infection This approach on its own may only be successful if the majority of cows are immune to BVDV from previous exposure.

What are the advantages of removing PI animals from a herd/group?

- As PI animals are the major source of infection, their removal from a herd or group will significantly reduce transmission of BVDV.
- If all PI animals are removed prior to joining, the risk of in utero exposure of the subsequent calf crop to BVDV will be low. This minimises or eliminates the proportion of PI calves introduced into the herd/group.
- In situations of high-stocking densities, the removal of PI animals may improve the efficacy of a BVDV vaccination program, because the animals are not constantly being challenged.

What are the disadvantages of removing PI animals from a herd/group?

- In large herds or management groups, removing PI animals may not be an option on economic grounds because of the large cost involved in sampling and testing individual animals.
- Removing PI animals prior to the subsequent joining is difficult in herds with long joining periods and requires the handling of fairly young calves. Females that abort calves infected with BVDV or deliver stillborn calves may also act as a source of infection of early pregnant cows running with them.
- Removal of PI animals also means that, over a period of several years, the proportion of susceptible cattle will increase substantially if no further PI animals are introduced into the herd or management group. Removal of PI animals from the herd should be combined with control options to minimise the risk of reintroduction of infection to the herd.
- Several rounds of testing may be required to identify all PI animals.
- Vaccination of the herd may be necessary in conjunction with removal of PI animals to achieve eradication where older cows remain at risk of BVDV infection and continue to give birth to PI calves.

Biosecurity measures

Important consideration

In situations where there is a high percentage of susceptible cattle in the herd or management group, the consequences of infection are high if biosecurity fails.

How can you minimise the risk of BVDV introduction from outside animals?

- Establish a closed herd and only use semen and embryos from confirmed BVDV-free donors
- Test all introduced cattle, including bulls, to confirm that they are not persistently infected.
  - Until test results are available, introduced cattle should be quarantined away from the main herd.
  - As transiently infected cattle can sometimes transmit BVDV, introduced cattle should be quarantined for a minimum of 6 weeks.
  - In the case of pregnant females, no tests are available to determine whether they are carrying a PI foetus – introducing pregnant females should be avoided or these females should be quarantined on the farm and their calves tested to confirm that they are not persistently infected.
- Minimise over-the-fence contact between breeding females and neighbouring cattle. This can be achieved by avoiding grazing females in boundary paddocks, or in some cases, using double-fencing.
- Vaccinate cattle that are going to be transported off-farm and later returned (e.g. travelling to agricultural shows, agistment, markets) 8 weeks prior to movement.

How can you minimise virus transmission within a herd?

Avoid mixing cattle from different management groups

- Avoid mixing different groups immediately prior to and during mating. This will minimise the risk of *in-utero* transmission of BVDV and the risk of the birth of a PI calf.

Minimise BVDV transfer via formites

- Clean cattle handling, transport and husbandry equipment and protective clothing between different herds/groups of cattle, and particularly between properties.

How can you reduce the risk of BVDV introduction via use of artificial breeding technology?

- Use semen and embryos for artificial breeding that have been collected in registered/certified artificial breeding centres to export standards.
- Test and confirm that embryo transfer donors and recipients are PI-negative. Vaccinate recipients 8 weeks prior to embryo transfer.
- Use BVDV-free media for washing, culturing and manipulating all embryo transfer materials.

What is the cost of implementing biosecurity measures in your operation?

The major costs to consider here are those related to:

1. Establishing a self-replacing closed herd. This will often require utilisation of artificial breeding technology. An alternative approach is to only purchase replacement male and female cattle that have been tested and shown not to be persistently infected.

2. Ensuring the perimeter/boundary fences are kept secure.

A range of other biosecurity measures can be considered but the most important ones are those that focus on preventing the introduction of a PI animal. The actual costs of implementing these measures on farm will vary considerably and so biosecurity measures must be tailored to each enterprise.

Vaccination in feedlots

Important consideration

To minimise the effects of BVDV in the feedlot, animals should have a high level of immunity to BVDV prior to entry into the feedlot, and/or the risk of exposure to BVDV should be minimised. Vaccinating calves prior to transport to feedlots would decrease the number of susceptible calves.

What are the benefits of vaccination?

- An appropriately administered vaccination program prior to transport to the feedlot provides a defence against BVDV infection in the feedlot for those animals without natural immunity.

What are the disadvantages of vaccination?

- Vaccination needs to occur on the breeding or backgrounding property while the benefits of a reduction in the incidence of bovine respiratory disease (BRD) are realised at the feedlot.
- Some groups of calves previously exposed to the virus may already have sufficient natural protection, making vaccination redundant.

What is the vaccination protocol for a feedlot operation?

- For optimum effectiveness, vaccination needs to be performed twice, at least 4 weeks apart, and at least 2 weeks prior to shipment.

Identification and removal of PI animals prior to entry into a feedlot

Important consideration

This approach requires considerable cooperation between the feedlot and ALL its suppliers of cattle. In the event that the feedlot allows entry of cattle from suppliers who have not screened their cattle for PIs, these cattle should be isolated and screened by the feedlot before being allowed to come in contact with resident screened cattle.

What are the benefits of identifying incoming PI animals and removing them from pens or mobs prior to feedlot entry?

- PI animals are the most important source of the BVDV virus. Research has shown that removing PI animals may decrease the incidence of BRD, presumably due to a decrease in the transmission of BVDV.

What are the disadvantages of identifying incoming PI animals and removing them from pens or mobs at feedlot entry?

- BVDV is very efficiently transmitted while cattle are yarded and during transportation. Much of the viral transmission associated with BRD could have already taken place before arrival at the feedlot. Removing PI animals on the source property is recommended but requires vendor cooperation.

How are incoming PI animals identified prior to feedlot entry?

- There are several testing options available for diagnosing PI animals prior to or on arrival at the feedlot.

What is BVDV costing you in terms of herd or group losses?

Economic modelling has been used to determine the likely economic impact of BVDV infection in beef and dairy herds. A range of scenarios have been modelled.

Modelling was conducted by Dr Phil Holmes of Holmes and Company, with modelling assumptions provided by Prof. Michael McGowan for beef and Dr Peter Younis for dairy. Modelling assumptions were based on case studies of the impact of BVDV in beef and dairy herds, both published and unpublished and cattle and milk prices that were current at the time of modelling. Further details of the modelling conducted are available from Zoetis Australia.

Modelling indicates that in beef herds, the major cost of BVDV is evident in the lack of surplus stock – both steers and heifers for sale and replacement heifers for the herd. Modelling of dairy herds indicates that the major cost of BVDV is evident as a reduced in-calf rate, reduced days in lactation, and the loss of replacement heifers.

For further information please review
www.bvdvaustralia.com.au

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Zoetis Australia Pty Ltd. ABN 94 156 476 425. Level 6, 5 Rider Boulevard, Rhodes NSW 2138.