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Control of Bovine Viral Diarrhoea (BVD)

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key points

- Bovine Viral Diarrhoea (BVD) is a contagious disease of cattle occurring worldwide and many livestock farmers rate it among their highest economic and welfare concerns
- BVD is caused by a pestivirus, Bovine Viral Diarrhoea Virus (BVDV) and is responsible for a range of different clinical outcomes, including infertility and reproductive problems, respiratory and gut disease, and in some cases fatal Mucosal Disease (MD)
- The main effects occur when susceptible pregnant cows become infected with BVDV which can cross the placenta, colonising it and causing disease in the developing foetus
- If infection occurs in the first half of pregnancy, the foetus can die and be reabsorbed, presenting as infertility or 'repeat breeding'. Some infected foetuses die later and may be aborted or stillborn. Many foetuses, however, survive to term. Some may be weak or grow poorly but most appear normal
- All calves surviving foetal infection in the first half of pregnancy are persistently infected (PI) with the virus, which is present everywhere in their bodies. They will not produce antibodies against BVDV
- Once colostrum-derived antibodies against BVDV have waned, PI calves will excrete virus continuously for the rest of their lives. They will rapidly infect other cattle that are in close contact. They may also develop MD (a fatal enteric disease) at any age
- If a PI cow breeds successfully she will always produce a PI calf
- Cattle that are not infected as foetuses cannot become persistently infected. These cattle may be transiently infected later, and their immune systems can be temporarily dampened down by BVDV, making calf pneumonia and scour more severe. Occasionally, virulent strains of BVDV can cause severe illness and death
- Bulls transiently infected with the virus may become infertile for several months and can transmit the virus to susceptible cows in their semen
- Control and prevention of the infection can be achieved by applying strict biosecurity procedures, vaccination and long term control strategies
- Several countries have successfully eradicated BVD

introduction

BVD is a contagious disease of cattle occurring worldwide and many livestock farmers place it among their highest economic and welfare concerns. It is caused by a pestivirus, BVDV, and is responsible for a range of clinical outcomes, including infertility and reproductive problems, respiratory and gut disease and, in some cases, fatal MD. BVDV is one of the most widespread and successful animal viruses in the world and is endemic in most European cattle populations. BVD affects both dairy and beef herds causing significant losses due to poor production and condition. Because the virus can cause immuno-suppression it can also make cattle more susceptible to other infections such as pneumonia and scour.

The climate change emergency, urgently requiring us all to embrace low carbon farming practices, now plays a major role in the drive to improve the efficiency of production in the livestock sector. Improving livestock health was recently identified in the UK Committee for Climate Change report (https://www.theccc.org.uk/publication/land-use-policies-for-a-net-zero-uk/) as one of the most important areas where benefits to both farm profitability and low carbon farming practices can be gained. BVD control would have a significant effect on the sector reaching these targets.

Successful national BVD control campaigns in countries such as Norway have shown the significant economic benefit to livestock producers. The Scottish Government is currently backing an industry-led eradication scheme for BVD. Estimates indicate that the programme is worth £2000-£14000 per year to the average BVD negative farm, depending on farm type. If all cattle herds in Scotland were BVD negative, this would equate to increased farm income across Scotland of £2.4 million every year https://www.gov.scot/publications/eradicating-bvd-estimating-the-savings-to-farmers/

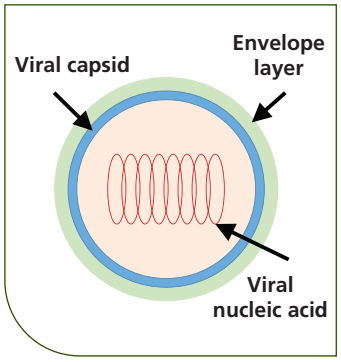

Figure 1:
A schematic BVD virus.

BVDV is a small enveloped virus with 3 envelope proteins and an inner capsid protein surrounding a single strand of genetic material (arrowed in the illustration). The major envelope protein on the outside of the virus is the most variable protein and is the major target for the host immune response. BVDV is related to border disease virus (BDV) in sheep and classical swine fever virus (CSFV) in pigs. There are two main groups of BVD viruses which may be distinguished antigenically and genetically. BVDV-1 is the most common and is widely distributed worldwide including the UK. BVDV-2 was first reported in Canada and the USA and has a more limited distribution. Both BVDV-1 and BVDV-2 have occasionally been associated with severe acute infection. An important property of BVD viruses is that they normally infect cells without killing them (known as non-cytopathic), they grow quickly and spread to infect many other host cells. The virus changes frequently and can become cytopathic (kills infected cells). This is the key event occurring in persistently infected (PI) cattle which leads to fatal MD.

For further information on BVD, including general advice on biosecurity, please visit https://www.moredun.org.uk/foundation/outreach/animation-series

The Scottish BVD Eradication Scheme: History

The Scottish Government is currently committed to support an industry led scheme to eradicate BVD from Scotland. The scheme started in September 2010 and is taking place in distinct stages.

Phase 1: Subsidised Screening: September 2010 to April 2011 - the Scottish Government subsidised the cost of testing herds for BVD.

Phase 2: Mandatory Annual Screening: All keepers of breeding cattle herds are required to screen their herds annually since Feb 2013.

Phase 3: Control Measures (reducing the spread of infection): Since January 2014 and included a ban on selling /moving BVDV infected cattle; declaration of herd BVD status prior to sale and a ban on moving animals from untested herds.

Phase 4: Biosecurity controls and further movement restrictions: From late 2014 - increased testing and movement restrictions on herds that are BVD not-negative and a requirement to test animals brought in to breeding herds from outside Scotland.

Phase 5: See the update on page 5.

The Scottish BVD Eradication Scheme: Update from the Scottish Government

Scotland's Bovine Viral Diarrhoea (BVD) eradication scheme began Phase 5 on 1st December 2019. This is the latest escalation of disease control measures for the scheme, which started as a voluntary programme in 2010. 90% of breeding herds are BVD Negative and the rate of PI removal is increasing.

Success

Industry engagement is essential for success. Scotland's BVD eradication scheme is industry-led and backed by Scottish Government legislation. Cattle keepers benefit from eradicating BVD from their herd, and the scheme relies on them to arrange and pay for BVD screening, and to act on the results. Farm vets, approved BVD laboratories, ScotEID's BVD helpline, NFU Scotland and livestock markets are all important sources of advice and information, and all are represented on the BVD Advisory Group, which guides the BVD eradication scheme.

Lessons learned

It can be hard for keepers to give-up on BVD Positive animals. Mandatory measures that force an active decision to "get rid" seem to help, e.g. restricting BVD herds that have one or more Positive animals, making the location of the herd public, requiring all Positive animals to be housed.

ScotEID provides an online "lookup" for checking BVD status of individuals and herds. This is still not used as widely as it could be, particularly when buying cattle. A quick check before moving new animals in could protect the herd from a BVD outbreak.

Points for cattle keepers

BVD is very infectious, brief contact with a PI, e.g. over a fence, is enough. All the PI's body fluids are infectious, and can be moved between herds on dirty boots, hands and equipment. Good biosecurity can save a lot of heartbreak. Consider housing PIs (mandatory from spring 2020), double-fencing at farm boundaries, vehicle hygiene and hand washing after handling PIs or cattle of unknown BVD status.

Protect Negative herds at all costs

BVD Negative herd status is valuable. Recently published figures show that the average-sized cattle farm will save £2,000 to £14,000 per year while it has a Negative status (amount depends on farm type).

- **PIs:** Many keepers follow best practice and kill BVD Positive animals soon after they are disclosed, but some try to finish them. Experience suggests that this is a false economy. PIs are a constant risk to unprotected cattle and our data shows that only 1 in 5 BVD Positive animals reaches the abattoir, suggesting that retaining Positive animals is a bad investment.
- **Beware of Trojan cows!** These BVD Negative in-calf females are purchased in good faith. The buyer assumes that the calf will share its dam's Negative status, but if the dam was exposed to BVD infection in the first 120 days of pregnancy, the calf could be a PI. If in doubt, calve these purchased females in isolation and test the calf for BVD antigen/virus as early as possible. Trojan cows can cause severe BVD outbreaks if the calf is not dealt with promptly.
- Make full use of ScotEID. Cattle keepers can log in to their own herd records on ScotEID to check their herd status and identify animals that need testing. It's the best way to avoid losing Negative status through missing a deadline or forgetting a calf. Access is free, the BVD Helpline can advise: 0300 244 9823.
- Remember that all cattle in Scotland can go direct to an abattoir for slaughter, provided that they are fit to transport. Direct transport to an abattoir is permitted regardless of the individual or herd BVD status.

Scottish Government

It is important for all cattle farmers to remember that the disease continues to be present in the UK and the threat of re-infection in negative herds is very real.

Q1 What are the clinical signs of BVD?

The most common clinical signs of BVDV are infertility and abortion, diarrhoea and mucosal disease. As the virus can suppress the immune system, animals infected with BVDV may suffer respiratory or gut infections. Rarely, other diseases are seen, including bone marrow disorders that cause bleeding. In addition, a range of outcomes can depend on whether the infected animal is pregnant and on the strain of virus.

1. Acute BVDV infections: Non-pregnant cattle

In healthy cattle which have not been exposed to BVDV previously, infection often passes unnoticed. This is known as transient infection (as opposed to persistent infection – see later). Mild clinical signs such as dullness, loss of appetite and diarrhoea may be seen, although it is thought that 70-90% of infections cause no obvious clinical signs. Following infection, animals may shed low levels of virus for up to 3 weeks. The host immune response helps to clear the infection, with antibodies being produced 2-4 weeks post-infection. BVDV-specific antibodies can persist in animals for several years and have been shown to prevent re-infection.

A common characteristic of BVDV infection is that it is immuno-suppressive, lowering resistance of the animal to other common opportunistic respiratory and gut infections. Acute infection can occasionally result in more severe disease involving acute diarrhoea, a reduction in milk production and fever with some cases proving fatal. Acute haemorrhagic disease outbreaks with high mortality rates in calves have been reported, both in the EU and UK. This syndrome is associated with bone marrow damage and severe enteric disease.

2. Acute BVDV infections: during breeding

If cows get infected with BVDV while pregnant, it may result in lowered herd fertility, an increase in the number of barren cows and a reduction in the numbers of calves born in the subsequent calving season.

3. BVDV infection in bulls

Bulls infected with BVDV may become temporarily infertile due to sperm abnormality. This may last several months with shedding of virus in the semen during this time, risking transmission of BVDV to susceptible cows during mating. Rarely, the virus can remain "sequestered" in testicular tissue with intermittent shedding.

4. Acute BVDV infections: during pregnancy

If infection occurs in a susceptible (naïve) pregnant cow, BVDV can invade and infect the placental tissues, crossing over to the developing foetus. The stage of pregnancy when infection occurs has a significant influence on the clinical outcome and the younger the foetus the more severe the clinical consequences:

- Infection of the foetus in the first 120 days of gestation may lead to death and reabsorption, abortion, mummification or stillbirth. If the foetus survives until full term, it will be born persistently infected (PI) with the virus and will remain so for life.

  PI cattle do not usually make a detectable immune response to the virus despite being infected and shedding BVDV into the environment continuously. This is because the foetus was infected when its own immune system was undeveloped. The immune system tolerates the virus and does not respond against it. Female PI animals that reach sexual maturity may have reduced fertility and will always produce PI calves

These PI animals are the major source of BVDV within herds because they shed infectious virus continuously every day, risking infection of other susceptible cattle.

- Infection with BVDV during the second trimester of pregnancy (up to day 190) may result in some stillbirth/abortion or birth of calves with abnormalities. Infection occurring from around day 140 of gestation will stimulate an effective immune response which enables the foetus to clear the infection. These calves are born with virus neutralizing antibody in their blood and are free of the virus
- Virus infection later than day 190 of pregnancy usually results in the birth of a live calf that is free of virus and carries specific antibodies against BVDV. See Figure 2

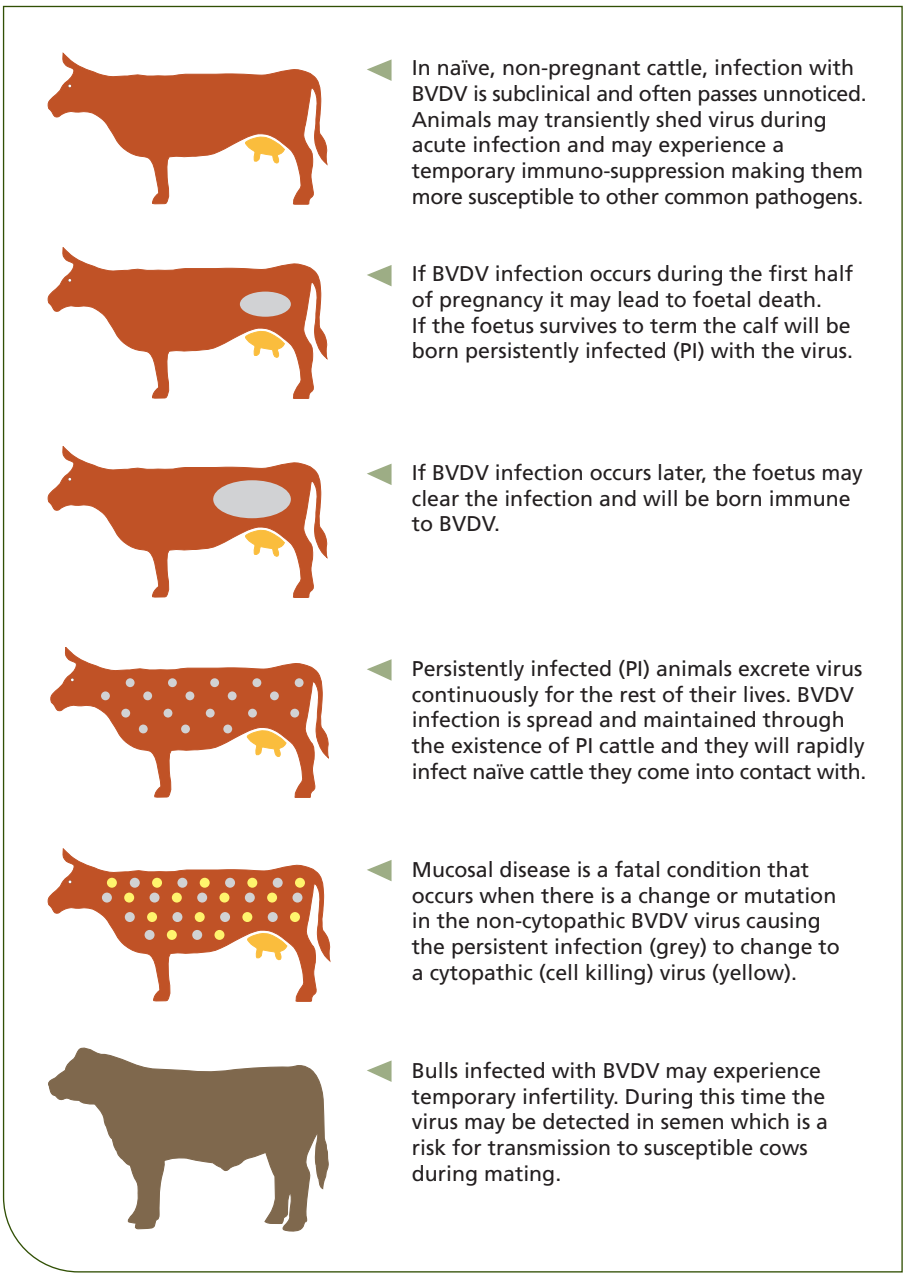

Figure 2:
Different clinical outcomes following BVDV infection of cattle

Mucosal disease (MD) is a fatal condition that affects PI calves, usually between 6-18 months old, though animals of other ages, including cows that will have already had a calf, may be affected. MD presents as weight loss, bloody diarrhoea, dehydration, and ulcerated lesions in the mouth, nose and the interdigital surface of the foot, making it hard for the animals to walk. It is caused by a mutation or change in the non-cytopathic (see box page 3) BVDV virus present in the PI calf, which mutates to a cytopathic (cell killing) form. This new cytopathic virus will spread and cause severe disease within the animal. This new cytopathic virus can also be transmitted and may cause mucosal disease in other animals that are persistently infected with the same (non-cytopathic) BVDV strain, such as may occur when several PI calves are born as a result of a single PI animal having contact with a group of pregnant cows, producing PI calves carrying the same virus strain.

Q2 How do I know if I have BVD in my herd?

Many farmers may not be aware of the infection status of their herds although Phase 5 in Scotland means that all Scottish farmers will know their herd BVD status. In the rest of the UK currently the first signs of BVDV infection in a herd may be some of the clinical manifestations discussed above.

Confirmation of BVDV requires specific laboratory tests that detect either the virus or BVDV-specific antibodies produced to fight the infection. Samples normally used for diagnostic purposes include blood, milk, bulk milk, nasal secretions, semen and tissues. Ear tags designed to take a tissue sample from the ear while tagging the animal can be a useful way to individually test calves born within the herd.

Evidence of infection

Methods used to detect virus include virus isolation to confirm active infection; immuno-histochemistry to show the presence of virus antigen in fixed or frozen tissue sections; an antigen ELISA test to detect the presence of BVDV antigen in blood, serum or bulk milk and the detection of virus nucleic acid using molecular techniques. Genetic techniques may also be applied to determine the specific genotype of the virus. Most virus antigen tests will detect virus in the blood of PI calves at birth. However, when these PI calves first suckle from their dams the high levels of specific antibodies in the dam's colostrum can temporarily mask the virus in the blood when ELISA tests are used. Molecular tests will usually detect virus nucleic acids in the blood after colostrum has been sucked, but sometimes even these tests will fail to detect virus. Both test types will reliably detect virus in the blood of PI calves at 1-4 months old once the colostral antibodies have decayed. Molecular tests and some of the ELISA tests are reliable in detecting virus in ear tag samples even after colostrum has been suckled because virus in the tissue sample is protected from circulating maternal antibody.

Detection of BVDV specific antibodies

Specific antibodies may be detected in plasma/serum or milk using antibody ELISA tests. These tests are commonly used to screen for the presence of BVDV infection in groups of animals that are otherwise considered to be healthy. This is best done in groups of calves that are 9 months of age or older when all colostral antibody to BVDV will have disappeared and should be done prior to vaccination, if this is to be used. A negative antibody test for the group would suggest that these animals have not been exposed to BVDV virus and therefore, there is not likely to be a PI animal in the group. Bulk milk testing is also most effective where the numbers of antibody positive animals in the herd is low or zero and regular monitoring (every 3 months) will offer an effective early warning signal of BVDV activity in the herd. Cattle vaccinated against BVDV will have virus-specific antibodies and should not be tested using an antibody detection system.

- Animals that are **antibody positive and virus negative,** have had a previous infection with BVDV (or vaccination) and are now immune
- Animals that are **antibody negative and virus negative** are free of BVD, but they are also susceptible to infection and keepers must take care to be vigilant with biosecurity and have regular screening checks to ensure the animals stay clear of the infection
- Animals that are **antibody negative and virus positive** are likely to be PI cattle but should be tested again after an interval of at least 3 weeks to be certain. PI animals will remain antibody negative and virus positive, whereas cattle undergoing an acute infection at the time of the first test will become antibody positive and virus negative
- **PI animals** should be culled. They should not be sold other than for slaughter and should never be sent to a market. Farmers in Scotland should consult their veterinary surgeon or other appropriate person to ensure they remain within the law, and that animals are likely to be fit for slaughter, when considering how to dispose of BVDV PIs

Q3 How does BVD get onto my farm?

- The major risk of contracting BVDV is through contact with PI cattle as these animals continuously shed infectious virus. Cattle that are in close contact are more likely to be exposed. The virus can be spread by nose to nose contact with cattle across a fence, so a gap of at least 3 m in fencing between fields is a good precaution. The virus may also be transmitted by transiently infected cattle and via infected semen. Persistently infected bulls excrete large amounts of infectious virus and should be culled. Only use bulls that are individually certified virus free and vaccinated
- Transiently infected animals may shed low levels of virus for up to 3 weeks and during this time are a risk to your herd
- Buying in cattle can be a source of BVDV infection and all new cattle should be isolated for at least a month and tested prior to introducing them into the herd. Farms that are accredited BVD-free, such as by Cattle Health Certification Standards (CHeCS), or animals that are individually certified virus-free and vaccinated should be preferred. Buying-in pregnant cows, or cows with calves at foot, is also risky because PI dams always produce PI calves and dams infected during pregnancy can also produce PI calves. All new pregnant cows should be calved down in isolation and their calves tested for BVDV as soon as is feasible

- Contaminated equipment, vehicles, bedding, dung or clothing is another potential source of BVDV. Although the virus does not survive long in the environment, it can remain viable in cool and damp conditions for a few weeks. Care should also be taken with visitors coming onto the farm and sharing equipment that has come into contact with livestock. Simple disinfectant treatment will kill BVDV on clothing and surfaces

Sheep and deer may very occasionally carry BVD, although transmission from these species to cattle is very unusual. Identification and removal of PI cattle, the major source of BVDV infection, will also reduce BVD infection in sheep and deer. Border Disease Virus, a related pestivirus of sheep, is an occasional cause of BVD-like disease in cattle. However, such cases are also rare.

Photo © Matt Colston

Figure 3:
BVDV can spread between animals that come in to close contact with each other in particular through nasal discharges and saliva.

Q4 BVD control options?

Consult your veterinary surgeon to ensure you are following any current national or local requirements for BVDV control. The general principles for control of BVDV are:

- Identification and elimination of PI cattle
- Biosecurity: Preventing the introduction of infection to your herd, especially to susceptible pregnant cattle and particularly during the first half of gestation

The chances of introducing BVDV to a herd increases with the number of animals brought in. To reduce this risk:

1. Use home-bred replacements.
2. Do not buy in pregnant animals if at all possible.
3. Purchase animals from herds accredited free of BVDV or test animals on arrival and isolate them until the results are known.

   Note: Testing of bulls before they can be used in artificial insemination centres has been compulsory now for many years and a standard requirement for international trade is that all breeding stock about to be purchased must be tested to ensure there are no PI animals.
4. Quarantine: Do not mix bought in stock with any of your herd, but particularly pregnant animals, until you know their BVD status.
5. Use vaccination where recommended, particularly before mating. Currently available vaccines are licensed to protect cows and heifers against transmission of the virus to the developing foetus and should be used exactly as directed for maximum effect. Vaccination of PI cattle does not control BVD and vaccination of a PI dam does not prevent infection of the calf. PI dams will always produce PI calves, even after vaccination.
6. Biosecurity: Farms should put a plan in place to minimize the threat from BVD. Double fencing with a minimum gap of 3 m is recommended to prevent cattle from neighbouring farms coming into close contact. Membership of a herd health scheme, such as CHeCS, with the advice of your veterinary practitioner, culling any PI cattle and purchasing only BVDV-free cattle will all help to control and remove BVDV from your herd. Taking steps to control BVDV infection and maintain vigilant biosecurity can bring real economic and welfare benefits.

For further information on BVD, including general advice on biosecurity, please visit https://www.moredun.org.uk/foundation/outreach/animation-series

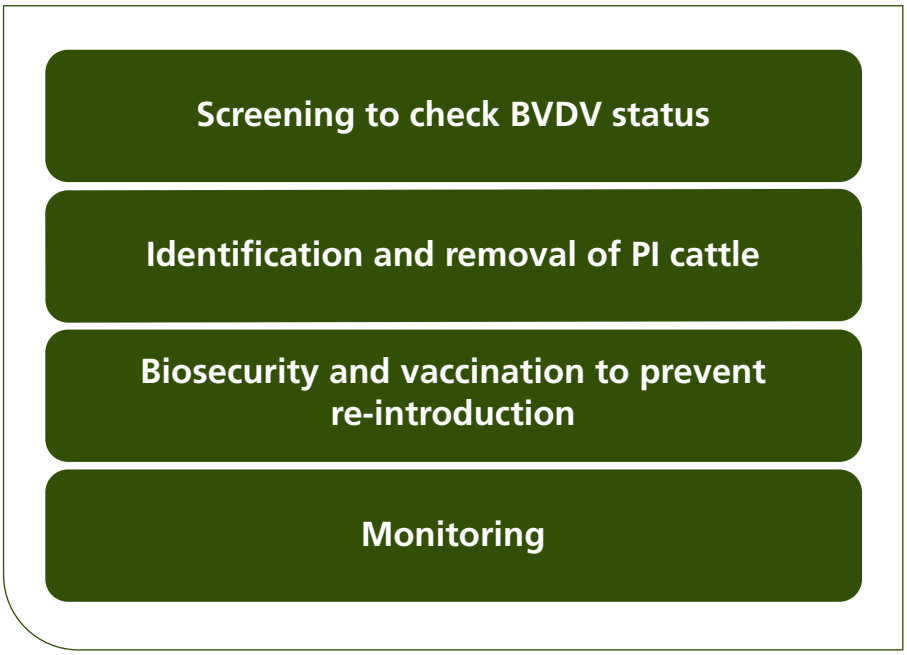

Figure 4:
The four stages of a herd health plan to help control BVD

Q5 Is BVD eradication feasible?

Access to reliable diagnostic tests and the availability of vaccines that protect against transplacental transmission of the BVD virus, means that there is a real opportunity to work together to eradicate BVDV. Currently, several European countries are free of BVD while others have advanced national or regional BVD control programmes. Scotland, Northern Ireland and Ireland are currently implementing compulsory programmes working towards BVDV eradication (see page 4) while voluntary regional schemes are in place in England and Wales.

The success of any eradication scheme relies on all stakeholders, including livestock keepers, vets, scientists, and those working in markets, abattoirs and other parts of the food chain, to work together and share knowledge and information on how best to prevent and control the spread of BVDV infection. As the eradication schemes progress, it will become increasingly important to be vigilant and rigorous about biosecurity.

As the BVD virus is genetically diverse and occurs worldwide, it will be increasingly important to continue our surveillance of new BVDV isolates and their ability to cause livestock disease. Due to this genetic diversity, there is an opportunity to type and trace outbreaks. It is essential that we maintain the ability to diagnose the virus strains and ensure that we have effective vaccines in place.

Moredun BVD research update

BVDV research at Moredun is focused on the development of methods for analysis of BVDV strains in samples from approved laboratories in Scotland. Using PCR and sequencing we can rapidly identify BVDV virus strains in large numbers of serum samples and we can also analyse tissue or milk samples on request. Molecular diagnostic techniques are also available to support investigations into abortion and still births. This allows us to help animal health agencies investigate BVDV outbreaks, identifying the strains involved and including/excluding potential sources of infection.

We are also looking more closely at the whole virus genome to help us understand how BVDV strains evolve within and between infected animals – studying calves of PI dams and along chains of infection. This may allow us to find out how some viruses may spread more quickly or cause more acute disease and provide data to support vaccine improvement.

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