BVD – the Disease and its Control

Professor Joe Brownlie

Royal Veterinary College, Hawkshead Lane, North Mymms, Hatfield, Herts, AL9 7SA, UK

Is BVD important?

Bovine virus diarrhoea virus (BVDV) is, undeniably, one of the most important viral diseases of cattle. The paradox for diagnosis is that clinical signs range from the inapparent to either severe haemorrhagic disease or fatal mucosal disease (see later), whilst its immunosuppressive effect can make other illness worse e.g. calf respiratory and enteric diseases. In recent years, there has been a growing awareness of its major role in reproductive loss; causing early embryonic loss, abortions and, even, neonatal calves born that are infected lifelong with BVDV. Fortunately, there are good diagnostic and control programmes available to us; the consequences of introducing this virus into a susceptible herd can be most severe.

What is BVD virus?

BVD is a virus (with the ungainly name of bovine viral diarrhoea virus **BVDV**!) that infects mainly cattle but can infect all cloven-hoofed animals (e.g. cattle, sheep, deer and pigs). It is in the same group of viruses that contains ***swine fever virus*** of pigs and ***Border disease virus*** of sheep. All three viruses share many similarities in the make-up of their viruses and in the diseases that they cause.

BVDV may exist in the cattle population in two distinct biological forms (called biotypes); one is non-cytopathogenic (BVDV nc) and the other is cytopathogenic (BVDV c). The BVDV nc biotypes do not kill cells when it is grown in culture (i.e. there is no cytopathology) whereas the BVDVc biotypes do. The reason for our interest in the two different biotypes is that they cause different types of diseases. It is only the BVDV nc biotype that persists in the cattle population, (mainly in calves that become persistently infected); however, we now know that it gives rise to the second biotype, BVDVc, by a complex process of mutation. The practical importance of understanding this is that on any farm with animals that are infected with BVDVnc, there is always the random chance of creating (by mutation of the BVDV nc) the second viral biotype (BVDVc).

What are the diseases caused by BVD?

Acute BVDV infection

- Acute BVDV infection in non-pregnant cattle is generally inapparent to the stockman. It is a common infection with an estimated 95% of milking herds within the National Herds having evidence of infection to BVDV (the presence of BVDV antibodies in milk or serum provides evidence of previous infection). However, with the acute infection, there is inevitably a fever and a temporary immuno-suppression for about 1-2 weeks.

- Under certain circumstances, it is clearly evident that BVDV can cause clinical disease; the original 1946 description of BVD in the USA was of a transmissible disease, for which the most prominent sign was profuse diarrhoea in adult cattle. Nowadays, we see more commonly episodes of milk drop and reproductive loss. More recently, a severe and fatal adult disease has been described in the UK following acute infection with up to 25% losses in the dairy herd.

- Since the late 1980's, episodes of severe disease have been reported widely in North America; it is recognised that this is due to a new and virulent group of BVD viruses (now called BVDV type 2 viruses). This is a haemorrhagic disease that can kill many animals within a few weeks; losses of many thousands of cattle have been reported in both USA and Canada. So far, these BVDV type 2 viruses have not been isolated from cattle in the UK or Australasia.

Infection of the unborn calf

- Although BVD virus rarely infects the unborn calf of immune cattle, it will certainly infect the unborn calf inside those dams that are not immune to BVDV. These dams have no protective antibodies.

- Infection in the early pregnancy of susceptible dams causes embryonic death, infertility and "repeat breeder" cows. In one study of a herd infected with BVDV, conception rates were reduced from 78.6% in the immune cows to 22.2% in infected cattle. In a further study, BVDV infection at the time of conception reduced pregnancy rates from 79% in the control animals to 33% in the virus infected group.

- A real problem of infection of the unborn calf is that a proportion of them remain infected for life. After they are born, these **persistently infected calves (PI)** then become the main reservoir for BVD virus for other cattle. In control programmes, it is important to identify these PI animals and cull them.

- Infection during early pregnancy can also result in abortions (sometimes there can be many abortions), congenital damage or the birth of PI calves; the congenital damage includes weak calves that are unable to stand or suckle often with cloudy eyes. Sometimes the calves are just small and don't thrive well.

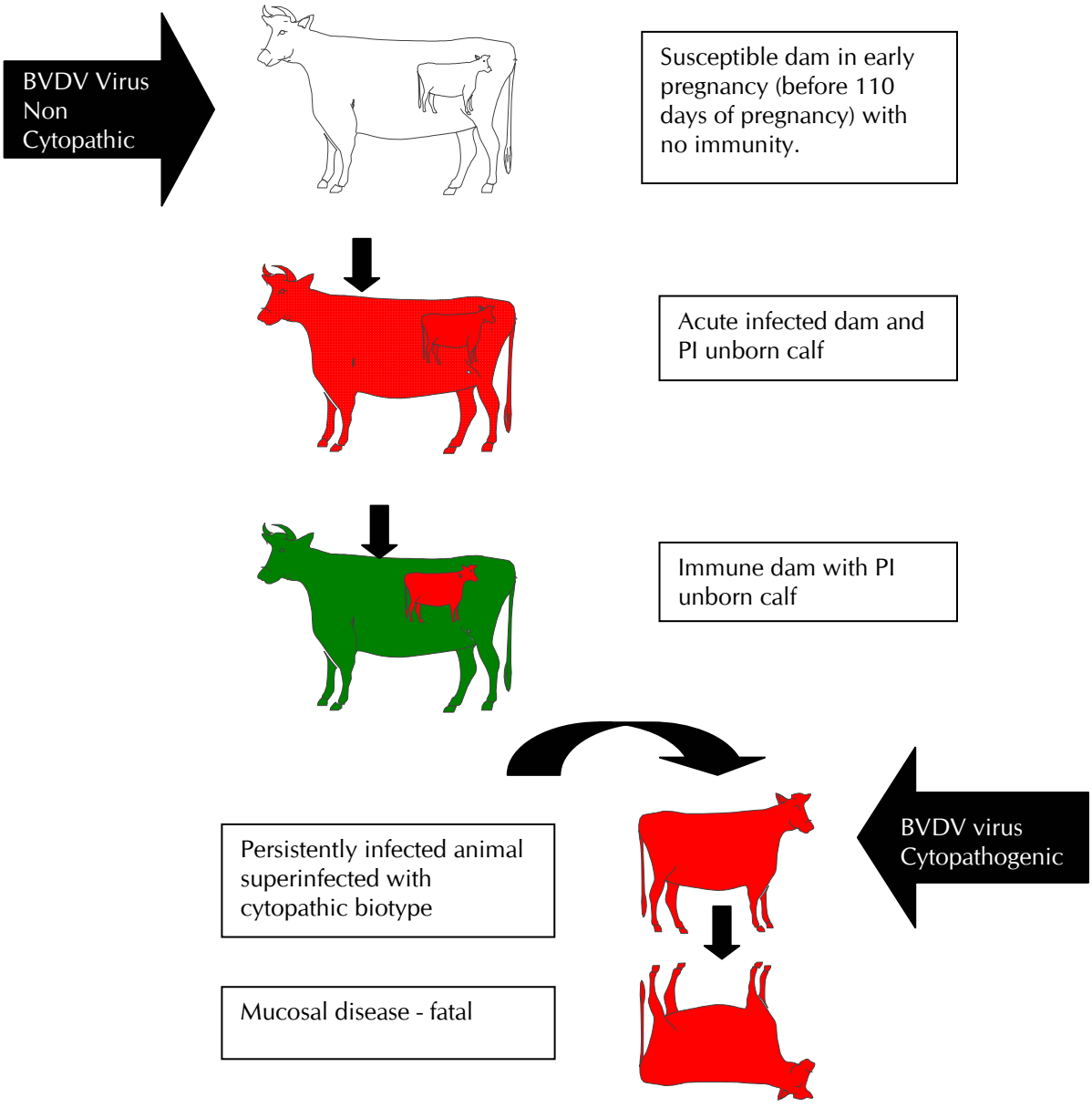
- Sometimes, PI animals remain alive long enough to reach reproductive age. When this happens, all their offspring become likewise persistently infected. This near 100% vertical transmission from dam to foetus is important when investigating disease outbreaks. Thus, the question to be asked of all PI calves is whether their mothers are also PI animals.

Mucosal Disease

- There is a fatal condition of cattle called Mucosal disease. Animals with it have severe erosions in the mouth and intestines, often profuse diarrhoea, and can die within hours of showing the first clinical signs. The cause of this disease remained unknown for nearly thirty years but now we know it is caused by BVDV. It is a complex story involving both biotypes of the BVD virus.

- The hypothesis that finally explained the cause of mucosal disease is complex; it is illustrated in Figure 1. The hypothesis states that an initial infection (with the non-cytopathogenic virus BVDVnc) of the dam in early pregnancy causes an infection of the early unborn calf. The unborn calf cannot resist the infection and the virus becomes established as a lifelong persistent infection (**PI**). These calves (and **only** these calves) may later develop the fatal mucosal disease as a result of 'superinfection' with the second biotype (BVDVc). In the field, mucosal disease usually affects animals of 6-18 months of age, although occasionally it has been reported in calves a few weeks old and adult cattle of 5-10 years.

Figure 1: Hypothesis for the pathogenesis of Mucosal Disease



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How much infection and disease is there in the National Herds?

BVD virus infection is widespread; it is, in fact, worldwide and found in many cloven-footed wild animals. In the UK, about 95% of herds have BVDV. The amount of disease caused by BVDV is difficult to quantitate; it is certainly the cause of reproductive losses and most likely to be a contributory cause of many calfhood illnesses. In all four Scandinavian countries, there are national BVDV eradication campaigns underway. These have been shown to greatly improve cattle health. In the UK, the only eradication scheme is in the Shetlands. As BVDV infection is so widespread in many herds, it will be necessary to have a combination of eradication of PI animals and a coherent strategy for BVD control with, in all probability, an accompanying vaccination programme to reduce the level of infection. This control strategy must be associated with an excellent programme of bio-security (as defined several recent Cattle Health schemes). All these measures will have to be in place before any large scale regional or national scheme of BVDV control is undertaken.

Which animals are most likely to show signs of the disease?

The most obvious disease caused by BVDV is mucosal disease, which is fatal and not treatable. This is usually seen in animals between 6-18 months. Cattle with it stop eating and are disinclined to move. They can have profuse watery diarrhoea although the disease can be so severe that they are just found dead. It is not uncommon to have either a single animal or a group of heifer replacement animals develop mucosal disease.

Less obvious, but of greater production loss, is the reproductive disease that causes infertility, repeat breeders and sometimes abortions. We would estimate that some 30% of early unborn calves are lost by abortion to BVDV infection in susceptible dams. The most vulnerable group are heifers and the first calving animals. However, if BVDV were to enter a 'closed' herd, then all pregnant cattle would be susceptible and the damage would be substantial.

How do you know if an animal is infected with BVDV?

The clinical signs of mucosal disease are characteristic and would be recognised by the veterinarian. The varied range of clinical signs caused by BVDV infection makes diagnosis difficult and this usually depends on laboratory testing for confirmation.

Sometimes, if an animal is a 'poor doer', fails to thrive or has recurrent episodes of diarrhoea or respiratory disease, there can be a suspicion that the animal may be persistently infected. Veterinary laboratory diagnosis will confirm this.

Can animals carry the infection without being obviously clinically affected?

Yes, this can be the most critical part of the diagnosis and control programme. Many of the PI animals look normal and it can be difficult to pick them out on clinical examination alone. However, as they are the main reservoir of infection, they have to be identified.

There is another way that infection can be carried in animals without obvious clinical signs. Pregnant cattle can appear normal but can be carrying unborn calves that are PI. Bringing in-calf animals into a susceptible herd can bring in infection following the birth of its PI calf; very much like the 'Trojan Horse' deception. Testing such animals can be difficult and laboratory advice should be sought.

Can animals other than cattle carry the BVDV?

All cloven-footed animals can be infected with BVDV. However, it is would appear unusual for any species, other than cattle, to be responsible for transmitting the virus to cattle. There have been reports of transmission between cattle and sheep but this is usually when they are closely housed together e.g. Scandinavian winter housing systems.

How do cattle catch BVDV?

The virus is transmitted between cattle by direct contact. BVD virus is present in all bodily secretions e.g. saliva, urine, nasal secretions and even skin cells. Curiously, in spite of the virus name, the least likely source is faeces. It has been reported that passive transmission by biting flies may occur. It can also be transferred between cattle by infected fomites carried on humans or machinery. If syringe needles are not changed between animals (for injection of vitamins or antibiotics), there is an increased likelihood to transmit the virus from PI animals to others.

BVDV is excreted in the semen of bulls that are either acutely infected (for about two weeks following infection) or persistently infected (in almost all collections for their lifetime). The infected bull is a frequent source of virus; it is critical that all bulls are screened for this virus before they are used. For this purpose, veterinary inspection is important.

Can you treat the disease successfully in sick animals?

There is no treatment for BVDV infection. For the acutely infected animals, natural recovery usually occurs in 2-3 weeks when antibodies appear in their blood stream. However, the persistently infected animal can never clear the virus and treatment is of no value. The best approach is to cull these animals. To sell these animals knowing that they are PI, could be considered contrary to fair trading.

Does our understanding of the infective process help to construct control programmes?

Our knowledge of the disease, and the importance of the PI animal in maintaining the infection within cattle populations, has proven to be an essential prerequisite to controlling BVDV infection. It is, admittedly, a complex disease and a shared programme of control and bio-security between the farmer and the veterinarian is all important. Failure to maintain correct bio-security can lead to serious disease breakdowns.

Is vaccination an appropriate part of control?

In some countries (e.g. USA), BVDV vaccines have been available for a number of years. It is also true that some of these same countries have high levels of infection and disease. We now recognise that vaccination, as a 'stand-alone' measure, appears insufficient to establish and maintain BVDV-free herds. However, in the last few years, the position has greatly improved with the license of excellent BVDV vaccines that offer good protection to the unborn calf. This can be done by vaccinating the dam before she is served, thereby ensuring that she is protected from BVDV infection during early pregnancy.

Vaccinating cattle with a reputable BVDV vaccine is highly recommended as part of a control programme. On many farms over the last few years, the use of a BVDV vaccine has given real improvement in reproductive performance.

Are the tests for BVDV reliable and sensitive?

BVD ***virus*** and ***antibodies*** can readily and reliably be detected in both blood and milk samples. These tests are reliable and can be carried out on individual animals or groups of animals.

What tests can be done and when?

The diagnosis of BVD hinges on the identification of virus (Virus isolation, Antigen ELISA, PCR, IPX) or evidence of exposure to virus (Antibody ELISA).

Antibody tests provide an indication of exposure and are therefore useful in assessing the status of a group of animals or a whole herd prior to, or as a part of a disease control programme.

Tests for BVD virus identify those animals that are persistently infected. It is these tests that should be used on a whole herd basis for virus eradication programmes.

- **Virus detection**

The critical reservoir of BVDV is the PI animal. The only certain identification of a PI animal is the demonstration of persisting virus. As the viraemia (virus in the blood stream) following acute infection is usually no longer than 10-14 days, any animal that has a positive viraemia on first sampling and also at second sampling taken three weeks, or later, can be considered persistently viraemic. These animals usually have low level or a total absence of specific BVDV antibodies in both samples.

Virus can be demonstrated by isolation of infectious virus or by viral antigen detection.

- **Antibody detection**

Demonstration of BVDV antibody provides an insight into the level of exposure to BVD virus within the herd. Diagnosis at a group or herd level is an important part of the assessment stage of a disease control programme. Blood can be taken from representatives of a group of animals and tested for the presence of antibodies to determine whether the group as a whole is likely to have been exposed to virus. A series of tests are available.

- **Bulk Milk Antibody Testing**

Milk samples can also be examined for the presence of antibodies. Whilst such tests on bulk milk provide only an 'average' figure for the milking herd, such testing allows a straightforward and simple method of obtaining an insight into the level of exposure to BVD virus within the milking herd. Pooled milk samples can also be tested for the presence of viral antigen to determine the presence of a PI animal within a milking group. This test is unlikely to give a positive result to acute viraemia.

In dairy herds, a sample of milk from the bulk tank should be submitted for antibody analysis; thereby giving an indication of the level of infection within the herd. Milk samples from freshly calved heifers can be taken to obtain further information on disease dynamics. Clear details and explanation of this cohort milk testing are available. Blood samples from a sample of 6 homebred heifers, aged between 8 and 18 months provides further information about the spread of the virus and the likely presence of a persistently infected animal.

The final part of the assessment stage should be a review of the risk factors for the reintroduction of virus into the herd. This is encompassed by the concept of bio-security. A thorough review of this programme should be a partnership between veterinarian and farmer.

Is eradication of the disease from a herd, a region or a country achievable?

This is a central question for many of us involved with herd health. The answer to all three questions is that eradication of BVDV is achievable but the likelihood of national eradication (as in the four Scandinavian countries) is limited at present. For a successful eradication campaign, we will need to reduce the level of infection in the national herd from 95% of herds. A combination of dedicated vaccination and the culling of all PI animals could considerably reduce the high national load of infection and create many virus-free 'clean' herds. However, at the same time, this must be accompanied by stringent bio-security measures to prevent re-infection of the 'clean' herds. It is in those 'clean' (usually 'closed') herds that the cattle have no immunity to the virus and, because they are highly susceptible to infection, we see the most serious outbreaks of BVDV disease.

With good bio-security, herds can remain free from BVDV and have improved herd health. The regions that has established and maintained BVDV eradication, e.g. Scandinavian countries and, in the UK Shetlands, are reported to have improve cattle health; they also have a commercial advantage for the international export of superior 'BVD-free' live animals. In the Scandinavian countries, the eradication programmes were all voluntary schemes strongly driven by informed farmers and veterinarians. Interestingly, in Denmark, it is now illegal to have, knowingly, a PI animal grazing at pasture.

What is the risk of reintroduction of the disease in a 'clean' herd?

There will always be a risk of reintroduction and this must be considered all the greater because of the high level of BVDV in the national herd. The risk can be reduced by effective and committed bio-security measures. Vaccination of susceptible herds may be an invaluable precaution until the time that there is national or region commitment to control of the virus

infection. It should not be forgotten that the major source of virus is cattle, particularly PI cattle, and, therefore, all newly introduced animals must be screened before they have contact with the 'clean' cattle in the home herd.

Does the disease have any human implications?

Over the 54 years since BVDV was first described in Cornell, USA, there have been no authenticated records of human infections with BVDV. It is not considered to pose any risk to human health.