IBR Eradication leaflet series

ANIMAL HEALTH IRELAND

Contributing to a profitable and sustainable farming and agri-food sector through improved animal health

IBR in Cattle

Frequently Asked Questions

Apparently healthy bulls may actually be latently infected and these are a risk to a naïve herd.

IBR Leaflet Series Vol. 3 Version 1.1 September 2020

IBR ERADICATION PROGRAMME

Animal Health Ireland, 2-5 The Archways, Carrick-on-Shannon, Co. Leitrim, N41 WN27

AHI gratefully acknowledges the financial and other contributions of our stakeholders.

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Q1 What causes IBR?

A viral disease of cattle

'IBR' stands for *'Infectious Bovine Rhinotracheitis'.* The disease spreads between cattle and can cause the nose and upper airways to become inflamed. The disease usually occurs when an animal is first exposed to a herpes virus called **'Bovine Herpes Virus-1' (BoHV-1)** *(Muylkens et al., 2007)* and so this virus is also known as IBR virus (IBRV). The severity of disease caused by infection with BoHV-1 can vary from inapparent to very severe *(OIE, 2010)*.

In this document, we will refer to any infection with BoHV-1 as 'IBR' even though many infections are not associated with obvious respiratory signs. An animal can therefore be infected with IBR (and test positive for IBR antibodies) even if it has never had the typical signs of disease.

See **Q3: 'How does IBR affect an individual animal?'** for more detail on the range of clinical signs that can occur after infection with IBR and the infection cycle in an individual animal.

IBR affects cattle trade

IBR-infected animals (and any associated products such as semen or embryos) cannot be traded to many regions and countries in the EU that are officially recognised as free of IBR (Denmark, Germany, regions of Italy, Austria, Finland, Sweden) or have an approved IBR control programme (Belgium, Luxembourg, regions of Italy and the Czech Republic) *(2004/558/EC and amendments)*.

From 2021, this legislation will be superseded by *REGULATION (EU) 2016/429 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 9th March 2016 on transmissible animal diseases and amending and repealing certain acts in the area of animal health ('Animal Health Law')* which makes provision for official approval of national and regional IBR eradication programmes within Member States, and provides continued protection for existing or newly recognised programmes. In addition, many third countries have IBR-specific requirements for live exports.

Non-EU countries that are IBR free (Norway, Switzerland) also restrict entry of test positive animals, while many third countries have specific IBR-related requirements for live imports.

In addition animals that have IBR antibodies following infection or vaccination with 'Conventional' (Non-Marker) or 'Marker' vaccines cannot enter semen collection centres in Ireland.

Bovine Herpes Virus-1 can cause other diseases

IBR can also cause a disease of the genital tract called *'Infectious Pustular Vulvovaginitis' (IPV; cows)* or *'Infectious Pustular Balanoposthitis' (IPB; bulls) (Muylkens et al., 2007).* At present, these diseases are not seen commonly in Ireland and abortion in pregnant females and pharyngitis (inflammation of the throat) in calves following infection with IBR occurs occasionally.

Bovine Herpes Virus-1 sub-types and strains

BoHV-1 Sub-types

There are three recognised sub-types of BoHV-1, based on DNA analysis *(Muylkens et al., 2007)*. Viruses belonging to different sub-types tend to be associated with particular disease outcomes, although the distinctions are not absolute.

- BoHV-1.1: Mainly causes IBR and can also cause abortion.
- BoHV-1.2a : Mainly causes IPV/IPB and can also cause abortion.
- BoHV-1.2b: Mainly causes IPV/IPB but does not cause abortion.

BoHV-1.1 Strains

There are different strains of virus within each sub-type. This is important as differences between strains may affect the severity of the disease they cause in an animal. In an experiment where young calves were exposed to different strains of BoHV-1.1 some strains caused severe disease and death where as others caused much milder disease *(Kaashoek et al., 1996)*.

Strain differences may account for some of the wide range of clinical signs that are reported from natural cases of infection with BoHV-1. There is no published evidence of any mismatch between the Irish field strains of IBR and those vaccines currently available on the Irish market. See **Q3: 'How does IBR affect an individual animal?'** for more detail on the range in clinical signs that can occur with IBR. Despite these differences, all sub-types and strains of BoHV-1 are considered to belong to the same viral species.

NOTE: When an animal is infected with any of these sub-types/strains it is considered to be infected with IBR virus.

See **Q8 'What tests are available to investigate IBR?'** for more details on testing an animal.

Other herpes viruses of cattle

There are other herpes viruses that affect cattle and cause diseases that are very different to those caused by IBR *(Banks et al., 2008; Muylkens et al., 2007)*. For example:

- BoHV-2 causes Herpes Mammillitis (producing teat ulcers).
- BoHV-4 has an undefined role but may contribute to reproductive disorders and mastitis.
- BoHV-5 causes herpes encephalitis (producing nervous signs).
- Ovine Herpes Virus-2 (a herpes virus of sheep) occasionally causes severe disease in individual cattle called 'Malignant Catarrhal Fever'.
- BLHV, (Bovine Lymphotrophic Herpesvirus) like OHV-2 above is a gamma-herpesvirus and has been linked with chronic, non-responsive metritis in dairy cows.

These other viruses are considered as separate species and not generally part of IBR disease syndrome.

Q2 How common is IBR in Irish beef and dairy herds?

IBR infection is very common

Infection with IBRV (the virus that causes IBR) is very common in Irish beef and dairy herds. Consistent with other countries that do not have a control programme, it is estimated that between 70% and 80% of all Irish herds contain at least one animal infected with IBR i.e. **70–80% of herds are 'infected herds**' *(Cowley et al., 2011).* There is no marked difference in prevalence between beef and dairy herds and both are very likely to be infected *(Cowley et al., 2011).*

Proportion of infected cattle varies between herds

The proportion of infected individual animals can vary widely between different infected herds. Some infected herds may have only a single infected animal. More commonly, many animals are infected, and in some cases all animals can be infected *(Geraghty et al., 2012; O'Grady et al., 2008).* Prevalence in suckler and dairy herds has been shown to increase with parity, herd size and purchasing *(Barrett et al. 2018).*

As IBR may not circulate continuously in infected herds, the length of time since the last virus circulation may be an important factor in explaining this variation *(Geraghty et al., 2012; van Nieuwstadt and Verhoeff, 1983)*. The structure and management of the herd may also influence the number of animals that are infected with the virus and the age at which infection occurs.

Q3 How does IBR affect an individual animal?

The course of infection in an individual animal

Figure 1 highlights the steps that an infection with IBRV (the virus that causes IBR) has in animals.

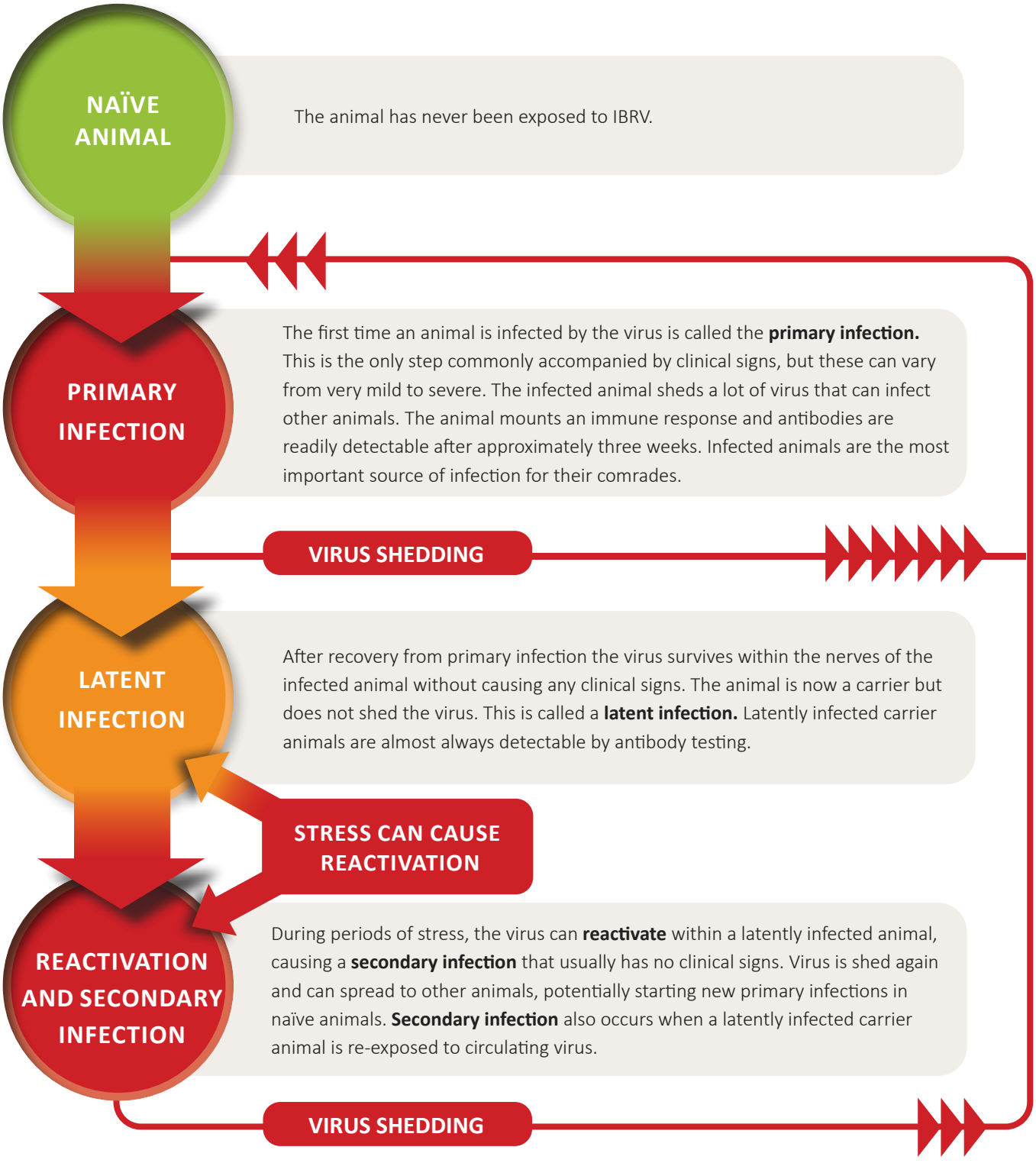

Figure 1. Infection cycle of IBR in an individual animal.

Only the primary infection is commonly associated with any clinical signs, although clinical signs may vary from minimal to severe, and in some cases may be absent.

Latent infection refers to a carrier state where the virus survives in an infected animal (though not causing disease or spreading). All animals that have had a primary infection should be considered to be latently infected.

Reactivation of latent infections provides a source of virus to create new primary infections in naïve (previously unexposed) cattle in the herd *(Muylkens et al., 2007)*.

Secondary IBR infections (either after reactivation or from circulating virus) usually produce minimal or no clinical signs.

Primary infection

IBRV typically infects an animal through the nose or mouth following direct contact with an animal shedding the virus *(Muylkens et al., 2007)*. The virus may also travel short distances (3–5m) in air *(Mars et al., 2000)*. Transmission at breeding (natural or artificial) and through indirect contact with infected animals is also possible.

Following primary respiratory infection, the virus damages the surface of the nose and the upper airways and may enter the blood to spread to other parts of the body.

NOTE: Some primary infections produce no apparent clinical signs while others can be very severe. *(EFSA, 2006; Muylkens et al., 2007)*.

The following clinical signs may be caused by (but are not unique to) IBRV infections:

- Dullness and reduced appetite.
- High body temperature.
- Rapid and loud breathing sometimes with coughing.
- Inflammation inside the nose and in the pink of the eye (conjunctiva) or less commonly on lining of male or female reproductive tracts.
- Fluid discharge from nose and eyes.
- Pharyngitis (inflammation of the throat).
- Sudden reduced milk production.
- Abortion.
- Nervous signs (only in young calves).

In addition, IBR can lead to marked respiratory disease and in severe cases death or long term ill-health. Remember that cattle with these signs are not definitely affected with IBR; it is important to discuss any suspect animal with your own veterinary practitioner.

Occasionally, young calves can also show severe nervous signs as the virus invades the brain *(Muylkens et al., 2007)*. These clinical signs are only seen in some cases. Many primary infections are inapparent. Factors that may influence whether clinical signs are seen during an outbreak include:

- The ability of the animals to fight infection.
- Concurrent infections.
- Whether animals have been vaccinated against IBR.
- The level of immunity (including colostral immunity in calves).
- The strain of the bohv-1 virus.

(EFSA, 2006; Muylkens et al., 2007)

Even within a single IBR outbreak, different animals can show different clinical signs due to individual animal differences in these types of factors. See **Q1: 'What causes IBR?'** for more detail on the different strains of BoHV-1.

Latent infection

NOTE: All animals that have a primary infection subsequently develop a latent infection.

During the primary respiratory infection the virus enters the nerves of the head. After recovery from the clinical signs, the virus is able to survive for the lifetime of the animal in these nerves. The virus is said to be in a 'latent' state *(Muylkens et al., 2007)*. This means that all animals that have ever been infected with IBRV are considered to be lifelong carriers. However, as the virus is 'latent' (i.e. not replicating or causing disease) the animal shows no ill effects and does not spread virus to other animals until reactivation occurs (see below). In almost every case, animals with latent infection will have antibodies against IBR that can be detected in blood and milk *(Muylkens et al., 2007)*. By testing for antibodies we can identify animals that are latently infected carriers.

NOTE: In very rare cases an animal can be latently infected but have no detectable antibodies, and therefore cannot be identified by a serological laboratory test. These are called 'sero-negative latent carriers'.

See **Q8 'What tests are available to investigate IBR?'** for more details on testing for latent infection.

Reactivation and secondary infection

IBRV within latently infected animals can re-activate to start a secondary infection and may spread to other, naïve animals. Secondary infections are almost never accompanied by any clinical signs because the animal already has some immunity from the primary infection *(Muylkens et al., 2007)*. Secondary infections (with no clinical signs) can also occur when a previously infected animal comes into contact with circulating virus (i.e. without reactivation). Over its lifetime, reactivation may occur multiple times within the same animal, interspersed with periods of latency.

NOTE: Reactivation is very important because it allows virus to be spread to uninfected animals in an infected herd or introduced to uninfected herds.

Virus may spread between herds when latently infected animals are introduced. If the virus contacts an uninfected animal a new primary infection will take place, with the risk of clinical signs developing. The level and duration of virus shedding is greater during primary infection than during secondary infection.

Reactivation may occur when an animal is under stress. Transport, calving, and high doses of immuno-suppressive drugs (e.g. corticosteroids) have all been shown to stimulate reactivation *(Thiry et al., 1987; Thiry et al., 1985)*. Other stressful events such as lameness, nutritional stress, mixing stock and other diseases are also likely to stimulate reactivation of latent infection.

Q4 How should I manage an animal with IBR?

Treating clinical infections

As the treatment required varies with the cause of the problem, veterinary examination of suspected cases is essential. Therefore, if you have an animal that is showing signs consistent with IBR, a veterinary practitioner should be called to examine the animal, confirm the diagnosis and discuss treatment.

There are several other diseases that cause similar signs, including lungworm, bacterial and other viral pneumonia, *mycoplasma bovis* and sunburn *(Radostits et al., 2007)*. Less common diseases like malignant catarrhal fever and some exotic diseases such as foot and mouth disease can also cause similar signs.

Specific treatment of the sick animal will vary on a case-by-case basis. If a diagnosis of IBR is made, the veterinary practitioner may advise immediate isolation and vaccination of the sick and 'at-risk' animals with intranasal vaccination to reduce clinical signs and control spread of infection.

NOTE: If animals are to enter a semen collection centre or bull testing station in the Republic of Ireland they must not be vaccinated with any type of vaccine (including 'Marker' vaccines).

See **Q3: 'How does IBR affect an individual animal?'** for more detail on the range of clinical signs that can occur after infection with IBR. See **Q13: 'How do I decide whether to vaccinate a herd for IBR?'** for more detail on vaccination.

Treating latently infected animals

There is no treatment (or vaccination) that can remove latent infection from an animal *(Muylkens et al., 2007)*. However, regular vaccination of latently infected animals can help to reduce reactivation and transmission to other cattle. See **Q13: 'How do I decide whether to vaccinate a herd for IBR?'** for more detail on vaccination.

IBRV infection does not cause any clinical signs when in a latent state *(Muylkens et al., 2007)*. If an animal is showing signs of ill-health it is unlikely to be due directly to latent infection and veterinary examination is required. See **Q3: 'How does IBR affect an individual animal?'** for more detail on primary and latent infections with IBR.

Q5 How does IBR spread?

IBR spread on a farm

Direct contact (e.g. nose to nose) is the most important method by which IBRV is transmitted from an animal that is shedding the virus to a susceptible animal *(Muylkens et al., 2007)*. The virus can also spread between animals over short distances in air (3–5m) e.g. between animals grouped in pens or across boundaries *(Mars et al., 2000)*.

The virus is highly contagious and it has been estimated that single animals shedding IBR can infect as many as seven more susceptible in-contact animals *(Hage et al., 1996)*. Newborn calves in very close contact with their previously infected dams are a particular risk group.

Virus Shedding

Virus can be shed during primary and secondary infections and following reactivation. The main routes of shedding are:

- In fluid from the nose, eyes and mouth.
- In the semen of bulls.
- In fluids from the female reproductive tract.

(Dennett et al., 1976; Muylkens et al., 2007)

Unlike other pathogens, IBRV transmission is not thought to commonly occur via milk or faeces. Latently infected animals do not continuously shed virus (Muylkens et al., 2007). The latent virus must first reactivate (usually following a period of stress or immune suppression) and then shedding may occur for a limited period of time (around 10–20 days) *(Muylkens et al., 2007)*. Any other animals that undergo a primary infection as a result during this time may get sick. These animals will shed more virus (than latently infected animals do after re-activation). This cycle allows IBRV to survive in a herd for a long time.

Figure 2a. Spread of IBRV following reactivation and shedding of virus from carrier animals.

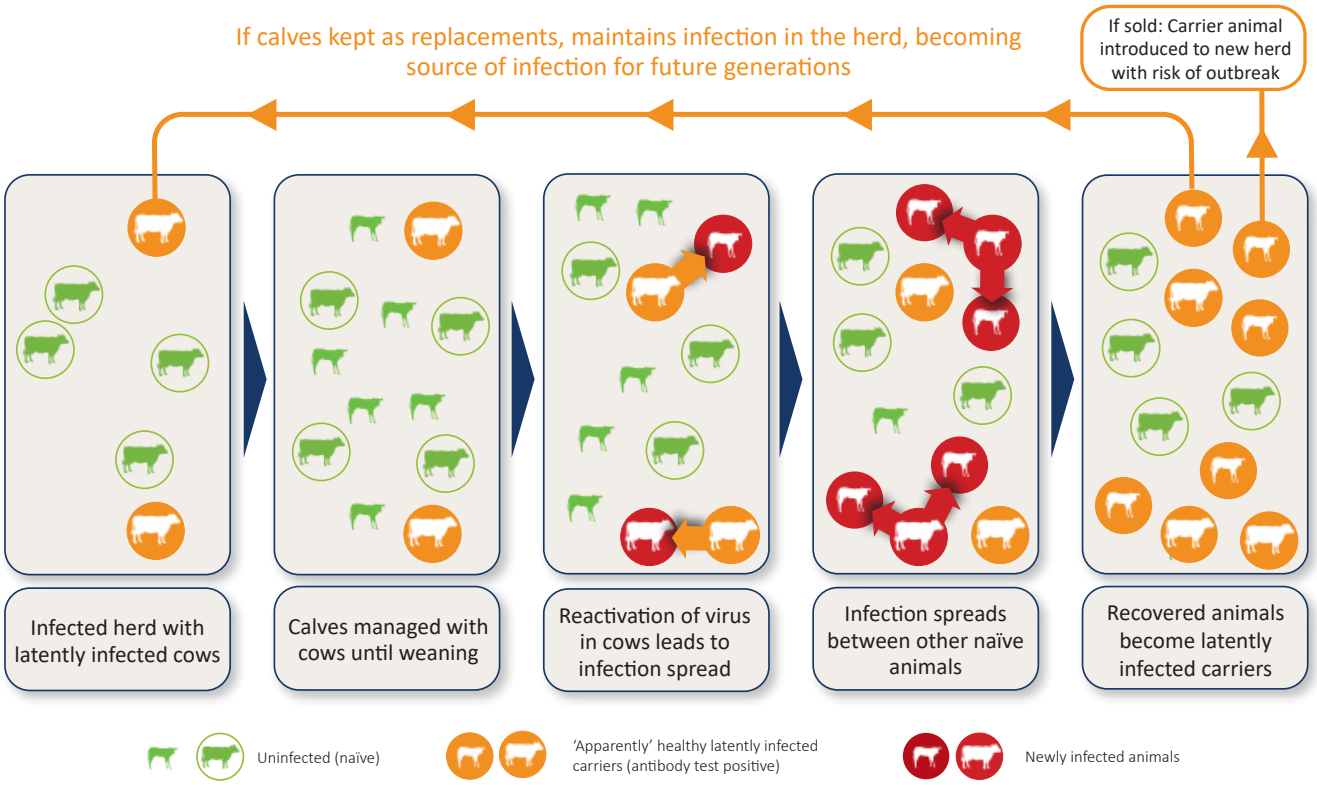

Figure 2b. Spread of BoHV-1 (IBR) in a non-vaccinating suckler herd following reactivation from carrier animals.

Indirect contact (the movement of infectious fluids on contaminated clothing, hands, feed or equipment) between animals may also allow virus to spread on a farm. The virus may also transfer indirectly between animals sharing feeding, drinking or bedding and can survive for several days off the animal. See **Q3: 'How does IBR affect an individual animal?'** for more detail on primary and latent infections with IBR.

See **Q11: 'What different options are available to control IBR in a herd?'** for information on reducing the source and spread of virus on your farm.

IBR spread between herds

There are several routes that allow IBR to spread between herds. See **Q7 'How do I stop IBR from coming into my herd?'** for information on reducing spread between herds.

Spread by introducing stock

The introduction of latently infected animals (that are carriers but have no signs of disease) is the most common way for IBRV to spread between herds. Any animal that has ever had a primary infection should be considered to be latently infected. In Ireland, because of the high prevalence of IBRV in the national herd, purchased animals should be considered as latently infected unless proven otherwise.

Animals are brought into herds for different reasons such as:

- Stock bulls.
- Replacements for culled animals in a beef or dairy herd.
- Genetic improvement and associated embryo recipients.
- Dairy heifers returning from a rearing centre.
- Fattening in a beef unit.
- Herd expansion.

These are all potentially high risk activities for introducing IBRV into a herd. The stress of transport and mixing may re-activate latent IBRV infection and cause an outbreak of disease soon after animals have been introduced.

Spread by close contact between animals

Close contact with cattle from other herds is the next most common method for IBVR to spread between between herds (EFSA, 2006).

Activities that allow direct or close contact (3–5m) between animals from different herds include:

- Inadequate perimeter fencing.
- Mixing stock for husbandry activities, at pasture, agricultural shows, marts or during transport.
- Animals breaking into/out of farms (and mixing with a neighbour's stock).

Spread by indirect contact (fomite spread)

Infected fluids (e.g. nasal discharge) that contaminate hands, clothing, farm equipment (nose-tongs, crush etc), feed or vehicles can spread IBRV between herds (EFSA*, 2006; van Schaik et al., 2001b).* Farm visitors that have close contact with stock may transfer the virus if they do not change or clean and disinfect their outer clothing and wash hands when moving between herds *(van Schaik et al., 2001b)*. Farm staff that contact stock in other herds pose a similar risk.

Spread by semen

Semen from infectious bulls can transmit IBRV between herds. However, the risk from semen obtained from collection centres approved for intra-community trade in the EU *(2003/43/EC)*, where bulls must be free from IBR, is negligible *(EFSA, 2006)*.

NOTE: All semen collection centres in the Republic of Ireland (ROI) must be approved for intra-community trade and therefore they present negligible risk of spreading IBR.

In some other EU countries, IBR infected bulls may enter semen collection centres provided that they are not approved for intra-community trade and semen collected is only used on the domestic market under these circumstances.

The risk of IBRV being present in semen from such collection centres is therefore increased *(EFSA, 2006).*

NOTE: It is illegal to import semen from non-approved IBR-permissive centres in other EU countries into ROI.

Spread by embryo transfer

Embryos can be contaminated with IBRV and therefore potentially spread virus between herds. The risk is generally low and depends on the exact methods that are used. The following practices reduce the risk of spreading IBRV by embryo transfer:

- Ensuring any purchased recipients are IBR-free.
- Sourcing semen from eu approved collection centres: See above *(2003/43/ec) (si112 1996)*.
- Sourcing ibr free donors and recipients.
- Washing embryos in trypsin (required by internationally approved processing protocols).
- Using IBR free donors of somatic cells and foetal calf serum.

(Givens and Marley, 2008)

See **Q8 'What tests are available to investigate IBR?'** for more information on ensuring animals are free from IBR infection.

When 'in-vivo' embryos are used (i.e. the egg is fertilised in a cow rather than in a laboratory) and the embryo is washed in trypsin as required by internationally approved protocols, the risk of transfer of IBRV is believed to be negligible *(Givens and Marley, 2008)*.

Spread by milk and faeces

IBRV can be shed in both milk and faeces from animals during primary and secondary infections and after re-activation of latent infections. While spread via milk has been shown to occur experimentally, spread of infection via slurry has never been documented *(EFSA, 2006; Probst et al., 1985)*. Movement of milk and faeces are not thought to be common methods of spreading IBRV between herds *(ESFA, 2006)*.

Spread by other species

Sheep, goats and deer can all be infected by IBRV and may present a small risk of spread between herds *(Mollema et al., 2005; Thiry et al., 2006)*.

Spread by insects or rodents

Transfer from from insects or rodents has never been documented and it is unlikely to be a common or significant method of spread of IBRV between herds *(EFSA, 2006; Taylor et al., 1982)*.

Q6 What are the likely consequences of having IBR infected animals in a herd?

Herd infections with IBR

IBR virus can affect a herd when it is first introduced or by circulating in a herd that is already infected. Most (but not all) herds in Ireland already have latently infected animals *(Cowley et al., 2011)*. The following describes possible outcomes that may that occur following both new infections and circulation of virus in infected herds.

Clinical impact of IBR can vary

IBRV can have variable clinical consequences ranging from being inapparent through to very severe in individual animals *(Pritchard et al., 2003; Wiseman et al., 1978)*. This means that, at the herd level, the negative effects may also vary from slight to more severe. What causes these differences is not fully understood *(EFSA, 2006; Muylkens et al., 2007)*.

Factors that may influence the consequences of having IBR in a herd are:

- The ability of the animals to fight infection and and ongoing causes of stress.
- Whether animals have been vaccinated against IBR.
- Concurrent infections- vira l, bacterial, parasitic.
- The level of immunity (including colostral immunity in calves).
- The strain of the BoHV-1 virus.

Even within a single IBR outbreak, different animals can show different clinical signs due to individual animal differences in these types of factors. While both the BoHV-1.1 and BoHV-1.2 subtypes have been identified in Ireland, their relative prevalence in Irish herds is unknown. See **Q1: 'What causes IBR?'** for more detail on the different strains of BoHV-1.

Herds with clinical cases

In some herd infections with IBRV the clinical impact is severe *(VLA, 2011; Wiseman et al., 1978; Wiseman et al., 1979)*. The virus can reduce the health and production of cows and calves *(Miller and Van der Maaten, 1986; Muylkens et al., 2007)*. The following consequences are associated with primary infections:

- Reduced animal welfare.
- Reduced appetite and growth rate/milk yield.
- Increased risk of pharyngitis and secondary bacterial pneumonia.
- Risk of abortion.
- Risk of death.

Some studies suggest that feedlot enterprises are more likely to suffer severe outbreaks than dairy or suckler herds *(Wiseman et al., 1978)*.

Purchasing for store, finishing or export markets

IBR is a recognised part of the 'respiratory disease complex' in herds where animals are purchased from multiple sources and mixed after purchase. Animals from multiple sources are often of unknown health status and have varying levels of immunity. Transport and mixing of cattle of unknown health status can result in clinical IBR disease (and other diseases) occurring within the group. Mixed infections with other disease causing viruses and bacteria (e.g. BVD) can result in more severe clinical IBR problems. Reduction of stress prior to and during transportation and after arrival on-farm can help minimise the problem. Use of IBR vaccines (ideally in advance of movement or on arrival on farm) can help control the contribution of IBR to the respiratory disease complex.

Follow the manufacturers' recommendations for vaccine use. See AHI CalfCare leaflet on the **Management of the Suckler Calf at Weaning to Prevent Pneumonia**.

In addition, these IBRV infected animals (and their associated products such as semen) cannot be traded to many regions and countries in the EU under current EU legislation *(2004/558/EC as ammended and 2003/43/EC)*. One of the drivers of national IBRV eradication policies within Europe, in addition to addressing the direct costs associated with the disease is to overcome trade restrictions.

Herds with no clinical cases

In some herds the clinical impact of infection with IBRV is much less severe. Clinical signs of IBR may not be observed in affected animals and a reduction in milk yield may not be consistently reported *(Geraghty et al., 2012; Hage et al., 1998; Pritchard, 1998; Pritchard et al., 2003; van Schaik et al., 2001a)*. These 'sub-clinical' herd infections are common in endemically infected areas like Ireland *(Muylkens et al., 2007)*. The direct impact that IBRV is having in such herds is likely to vary between herds and is very difficult to assess.

Specific herd goals

Animals that are either naturally infected with IBRV or that are vaccinated against IBR can never be taken into semen collection centres or bull testing stations in Ireland *(SI 112/1996 as amended)*. IBR-infected animals (and any associated products such as semen or embryos) cannot be traded to many regions and countries in the EU that are officially recognised as free of IBR (Denmark, Germany, regions of Italy, Austria, Finland, Sweden) or have an approved IBR control programme (Belgium, Luxembourg, regions of Italy and the Czech Republic) *(2004/558/EC and amendments*).

Non-EU countries that are IBR free (Norway, Switzerland) also restrict entry of test positive animals, while many third countries have specific IBR-related requirements for live imports.

When it is a specific goal of a herd to sell animals into semen collection centres, bull testing stations or to export them to restricted areas then the potential cost of having IBRV, even if the infection has no observed clinical impact, can be substantial.

At the national level, IBRV represents an ongoing risk to semen collection centres. It also puts a significant restriction on the number of animals that are eligible for entry into semen collection centres and as a consequence reduces the pool of genetic material available for selective breeding. Many international agricultural shows impose restrictions and enforce specific regulations against IBR.

Q7 How do I stop IBRV from coming into my herd?

Make a bio-exclusion plan

Bio-exclusion means preventing infectious disease coming into your herd from outside. The risk of IBRV coming into your herd can be controlled by implementing a bio-exclusion plan in conjunction with your own veterinary practitioner. Farmers are encouraged to find out the IBR status of their own herd as a starting point of any biosecurity plan.

To make a plan, any activities that might allow IBRV to enter your herd should be considered, and control measures put in place for each one. It is appropriate to prioritise the control of higher risk activities before addressing moderate and lower risk activities.

It may be helpful to read **Q5: 'How does IBR spread?'** before reading this section and making a bio-exclusion plan for your own herd. Further information can be obtained from the bio-security section of the Animal Health Ireland website **click here**.

Activities that may allow IBR to enter a herd

Higher risk activities

Introducing stock is the highest risk activity for allowing IBRV to enter a herd. Activities that allow direct or close contact between your own animals and animals from outside your herd are also higher risk. For example:

- Mixing stock at housing, pasture, during transport, agricultural shows or marts.
- Borrowing, loaning, other farms' bulls.
- Having poor perimeter fencing.
- Having animals break into/out of your farm and mix with other stock.

These are HIGHER risk activities and should be addressed first *(EFSA, 2006)*. The list is not comprehensive and any activity that allows direct or close contact with cattle from another herd should be considered HIGHER risk.

Moderate risk activities

Activities that allow 'indirect contact' between your herd and animals from outside your herd can also allow IBRV to enter your herd *(EFSA, 2006; van Schaik et al., 2001b)*. 'Indirect contact' occurs when animal secretions and excretions (nasal discharge, saliva, urine, dung etc) are moved between farms by a carrier. For example:

- Visitors with contaminated clothing moving between herds.
- Using contaminated farm equipment from another herd (e.g. nose tongs, crush etc).
- Allowing contaminated vehicles from another herd to contact your stock.

These are MODERATE risk activities and should be addressed next. The list is not comprehensive and any activity that allows indirect contact between herds should be considered as a MODERATE risk.

Lower risk activities

Lower risk activities are those which can in theory allow IBRV to spread but are not thought to occur commonly, such as embryo transfer and co-grazing with other ruminants *(EFSA, 2006; Givens and Marley, 2008)*. They should be considered only after HIGHER and MODERATE risk activities have been addressed.

Bio-exclusion control options

For each risk activity identified, there can be several different options to help control them. Table 1 indicates, for common activities that may introduce IBR, various control options and how effective they are likely to be.

Higher Risk Activities	Control Option	How effective will it be?
Purchasing and introduction of stock	Keep a closed herd (including no borrowing or purchasing of bulls)	Excellent
	Isolate any incoming stock for four weeks before testing for antibodies; only introduce test-negative animals[1]	Very Good
	Introduce stock only from IBR accredited free herds (and isolate for four weeks)	Good
	Buy stock from herds with no clinical signs of IBR and (and isolate for four weeks after arrival)	Poor
Mixing home stock with cattle from another farm at pasture, housing or by contract rearing	Do not allow home stock to mix with animals from any other farm	Excellent
Grazing stock in boundary fields with poor perimeter fencing	Do not graze boundary fields when there are neighbours' cattle in the adjacent field	Very Good
	Ensure all perimeter fencing is unbroken and maintains 5m between stock on a neighbours' farm	Very Good
Taking stock to a mart	Do not take stock to marts and allow them back home	Excellent
	Take stock to marts but do not allow them back home without isolating and testing	Very Good
Taking stock to an agricultural show	Do not take stock to agricultural shows	Excellent
	Only take stock to shows that require a negative IBR test result for all entrants; if no such shows exist encourage development of these through breed societies; isolate and test (as above) on return from the show	Good
Farm staff contacting external stock (e.g. at shows, farm walks etc)	Ensure all farm staff change outer clothing and wash hands before and after contact with any external stock	Excellent
	Ensure all farm staff disinfect all outer clothing and wash hands before and after contact with any external stock	Good
Moderate Risk Activities	**Control Option**	**How effective will it be?**
Allowing visitors that move between farms access to stock[2]	Provide visitors with clean, disinfected[3] (or disposable) outer clothing (that stays on the farm) and hand washing facilities before they contact stock	Excellent
	Ensure visitors[2] completely clean and disinfect[3] all outer clothing and footware before they contact stock	Very Good
Sharing farm equipment with a neighbour (e.g. nose tongs, foot-paring crushes etc)	Do not share farm equipment with a neighbour	Excellent
	Clean and disinfect[3] all shared farm equipment before and after every use	Very Good
Visitor's vehicles coming close to stock[2]	Do not allow visiting vehicles close contact with stock	Excellent
	Ensure vehicles drive through a disinfectant[3] bath before close contact with stock	Moderate- Poor
Conducting AI	Only purchase semen from collection centres approved to EU standard 2003/43/EC [4]	Excellent
Lower Risk Activities	**Control Option**	**How effective will it be?**
Conducting Embryo Transfer[5]	Only use *in-vivo* embryos (produced directly from live animals) that are processed according to guidelines from the International Embryo Transfer Society	Excellent
Shared grazing with sheep, goats or deer	Do not share grazing with sheep, goats or deer	Very Good

Table 1. Bio-exclsuion control options for activities that present high, moderate and low risks of introducing IBRV into a herd

[1] If introducing stock follow the Bioexclusion document guidelines, and see ***www.animalhealthireland.ie*** *for more information on testing animals. [2] This includes delivery/pick-up drivers and their helpers. [3] A list of approved disinfectants is available from the websites of DAFM* ***(www.agriculture.gov.ie)*** *and DAERA* **(https://www.daera-ni.gov.uk/publications/approved-disinfectants)**. *[4] All semen collection centres in the Republic of Ireland and all legally imported semen must meet these standards. [5] This does not include the risk of purchasing recipients, which is a 'higher risk' activity (considered above).*

Q8 What tests are available to investigate IBR?

Test types

There are two types of individual animal tests for IBR.

- Tests that detect virus directly.
- Tests that detect antibody against the virus.

It is important to note that no biological test is 100% accurate and decisions should be made on which tests to use and how many animals to test after careful discussion between the farmer and their own veterinary practitioner based on herd specific goals.

Tests to detect virus

Tests for the virus (BoHV-1) are usually performed on swabs taken from the nose, eye and throat of an animal (either live or post mortem). There are several different tests that can be used including virus isolation, FAT, antigen ELISA and PCR *(EFSA, 2006)* and tests for virus are normally used only to confirm IBR infection in an animal with clinical signs.

They can all be interpreted as follows:

A positive virus test result indicates that the animal was shedding virus when the swab was taken, and was therefore undergoing primary, secondary or reactivation of infection. Following primary infections animals will shed virus for around 10 to 20 days before becoming latently infected *(Muylkens et al., 2007)*. Animals may also shed virus for a similar period after intranasal vaccination with live IBR vaccine. See **Q12 'What types of vaccines are available against IBR?'** for more information.

A negative virus test result indicates that the animal was not shedding detectable levels of virus when the swab was taken. It may or may not be latently infected. See **Q3 'How does IBR affect an individual animal?'** for more information on primary, secondary and latent infections.

Tests to detect antibody

Antibodies are proteins produced by an animal's immune system and which reach detectable levels (test positive) 10-35 days after natural infection or vaccination. Antibody tests are performed either on blood or milk, most commonly using an ELISA test. There are two categories of ELISA antibody tests for IBR *(EFSA, 2006)*.

Whole virus or gB tests detect antibodies following natural infection or use of 'Conventional' (Non-Marker) or 'Marker' vaccines. or a gE test detects antibodies following natural infection or use of 'Conventional' (Non-Marker) vaccination.

Tests for antibodies may be used to determine whether an animal has been previously exposed to IBR (and can be presumed to be latently infected) or not. This information can be used in pre-purchase testing and screening or monitoring herd infection status. See **Q9 'How do I test a herd for IBR?'** for more information on testing a herd for IBR.

Interpreting an antibody test in an individual animal requires knowledge of the type of test used and the vaccinal status of the animal. Table 2 can be used as a guide for interpreting individual animal antibody test results. Calves less than six months old may have maternal antibodies resulting in positive test results.

Veterinary Technical Box

Choosing the right test for IBR

NOTE: Remember to use a gE-specific ELISA test in herds that are vaccinating with IBR 'Marker' vaccine.

'Marker' vaccines, 'Non-Marker' ('Conventional' (Non-Marker)) vaccines and field virus all cause production of antibodies to the glycoprotein B (gB) of IBR virus. 'Marker' vaccines do not contain glycoprotein E (gE) and therefore do not cause production of antibodies to gE. Field IBR virus and 'Non-Marker' ('Conventional' (Non-Marker)) vaccines do contain gE and therefore lead to production of antibodies to gE.

Animal Status	Detectable antibodies to gB/ whole virus	Detectable antibodies to gE	Most likely test results
Previous exposure to IBR virus (regardless of vaccination) OR vaccination with 'Non-Marker' vaccine (regardless of exposure)	Yes	Yes	gB or whole virus positive, gE positive
Unexposed but vaccinated with 'Marker' vaccine	Yes	No	gB or whole virus positive, gE negative
Unexposed and unvaccinated animal	No	No	gB or whole virus negative, gE negative

Table 2. Influence of animal status and test methods on test results.

In the Republic of Ireland, the only licensed vaccines are 'Marker' vaccines. The companion tests are called gE- specific because they detect antibodies to only a small part of the virus (the gE protein). This protein is missing from the 'Marker' vaccine but present in the virus strains responsible for natural infection and in 'Conventional' (Non-Marker) vaccines *(EFSA, 2006)*. See **Q12 'What types of vaccines are available against IBR?** for more detail on vaccination.

Antibody Test Reliability

No laboratory test is perfect and all can very occasionally give an 'incorrect' result. In general, test for IBR antibodies are very reliable and very rarely give misleading results. The 'Marker' vaccine companion test (gE) is a little less reliable *(Kramps et al., 2004)*. In addition, there is a longer delay between infection and becoming test positive for the 'Marker' test (21-35 days) compared to the gB and whole virus tests (7-14 days)*(OIE, 2016)*.

A test's *'Specificity'* score (0-100%) indicates how often the test will give a negative result when testing non-infected animals. A test's *'Sensitivity'* score (0-100%) indicates how often the test will give a positive result when testing infected animals. Table 3 gives approximated figures of test reliability for IBR tests (based on data supplied by test kit manufacturers and published reviews). The best possible test would have 100% sensitivity and specificity. These figures are current as at the date of publication and will be updated as more information becomes available.

Sample Type	General test*		Marker vaccine companion test	
	Specificity	Sensitivity	Specificity	Sensitivity
Individual animal **blood** sample	99	99	99	95
Individual animal **milk** sample	100	88	99	95

Table 3. Estimated specificity and sensitivity of selected IBR antibody tests

*Figures shown assumed for both indirect ELISAs and gB specific blocking ELISAs

False negative results occur more frequently as test sensitivity gets lower. False negatives can undermine bio-exclusion efforts if pre- or post-purchase testing is used as part of a bio-exclusion plan. False positive results occur more frequently as test specificity gets lower. False positives can undermine monitoring of herds for evidence of freedom from infection.

Q9 How do I test a herd for IBR?

Conducting a herd test

A herd test can be done by combining individual samples or test results to reach a conclusion regarding the status of the entire herd *(Christensen and Gardner, 2000)*. Herd tests for IBR typically use antibody based tests. Single samples from individual animals are of limited value to determine herd prevalence (the proportion of the herd with IBR).

Figure 3 indicates the various stages where herd tests can be used:

- To assess IBR status.
- To control programme planning.
- To control programme monitoring.
- To investigate suspect IBR problems.

NOTE: All samples from individual animals should be submitted with full tag numbers to ensure the future usefulness of test results to herd health planning.

Bulk milk antibody tests

A bulk milk antibody test (BMT) can be used as an initial screening test for a dairy herd. This is shown in Figure 3 as a step 1 investigation test. Regular BMT antibody tests may be used in negative/low prevalence dairy herds to monitor their status.

Negative bulk milk results with current kits will be obtained in herds where less than 10-15% of the milking cows are latently infected and there is little or no virus circulation. Antibody levels in the bulk milk will increase if the virus starts spreading within the milking herd. A positive bulk tank milk result will be obtained in herds with moderate to high prevalence of latently infected animals, recent circulation of the virus or herds that have been vaccinated (depending on the type of vaccine and test used) *(Nylin et al., 2000; Wellenberg et al., 1998)*. Individual animal samples are needed to more accurately determine how many animals are infected.

See **Q8 'What tests are available to investigate IBR?'** for more details.

Testing a proportion of the herd

Accurately estimating how many animals are latently infected is helpful in deciding what sort of control programme is most appropriate for a herd and in determining the next steps. This is shown in Figure 3 **(page 26)** as a step 2 investigation test.

How many animals should I test?

Two options are explored in this document: carry out a 'snap shot' test or test a proportion of the herd.

Snap shot test

A cost-effective means to obtain an initial indication of the level of infection in a given herd can be achieved by applying a 'snap shot' test. This can be used to get an initial indication of the within herd prevalence and in particular to determine if this is sufficiently low to justify the expense of a whole herd test to confirm freedom or identify the small proportion of positive animals present that require removal. A 'snap shot' requires the sampling of 30 randomly selected animals over 9 months-old that are used or intended for breeding. It is important to include animals of all ages and groups in this testing to obtain a result that truly reflects the status of the herd (or that part of it being assessed).

Which animals should I test?

The animals selected to be tested should be chosen at random (e.g. not targeting sick animals etc.) and should be selected representatively from the groups used to calculate herd size (e.g. all animals or adults only). Calves less than 9 months-old may have maternal antibody resulting in a positive test result.

How do I use the result?

If either none or only one animal is positive on the 'snap shot' test, the proportion of infected animals within the herd (within herd prevalence) is estimated to be between 0-15%. At this low prevalence, screening of the whole herd, to identify and remove any carriers present, is justified where herd freedom is the target.

If more than two seropositive animals are identified by the 'snap shot' test, the likely within herd prevalence is greater than 15%. In such herds, identification and removal of all carriers is unlikely to be feasible, and therefore other control measures are required until such times as a subsequent 'snap shot' test indicates that sufficient progress has been made.

More detailed testing to determine within herd prevalence

To more accurately investigate within herd prevalence e.g. following a positive 'snap shot' test or a bulk tank milk result, carry out testing as described below. The number of samples required is influenced by the herd size, the type of sample (e.g. blood or milk) and test (gB or gE ELISA), the desired accuracy of the estimate generated and the confidence associated with the estimate.

How many animals should I test?

Table 4 gives appropriate sample sizes required for estimating prevalence of infection in a herd to an accuracy of +/-5% in 95% of cases (i.e. a confidence of 95%; true prevalence will be within 5% of the estimate 95% of the time).

Test/sample	Herd size										
	<25	25-35	36-50	51-75	76-125	126-175	>176	≥275	≥375	≥475	≥575
Whole virus/gB Blood	21	29	38	50	68	81	97	97	107	113	118
gE Blood	21	29	38	50	67	79	95	95	104	111	115
Whole virus/gB Milk	21	28	36	47	63	73	86	86	93	98	102
gE Milk	21	29	38	50	67	79	95	95	104	111	115

Table 4. Sample size for IBR seroprevalence estimation in herds of various sizes

If you want to know the prevalence in the adults of the herd, only the adults should be included in the herd size figure when selecting your sample size. If you want to know the prevalence in the entire herd all animals should be counted in the herd size.

Which animals should I test?

The animals selected to be tested (once the number of animals is read from the table) should be chosen at random (e.g. not targeting sick animals) and should be selected representatively from the groups used to calculate herd size (e.g. all animals or adults only). Calves less than six months old may have maternal antibody resulting in a positive test result.

How do I use the result?

The result is used to estimate the percentage of animals in the entire herd that are likely to be infected. Divide the number of positive results by the number of animals tested and multiply by 100.

A worked example

A beef farmer with 70 adult cattle who does not vaccinate his/her animals against IBR wants to estimate the prevalence of infection in the herd. Because they are unvaccinated he/she uses the whole virus/gB blood ELISA. Using Table 4 the farmer is advised to test 50 randomly selected animals. The farmer then chooses these 50 at random to be bled by the veterinary practitioner. When the results come back there are 32 positive results and 18 negative results.

32/50 X 100 = 64%

Allowing for the accuracy of the estimate, the farmer can be 95% certain that between 59% and 69% (64+/-5%) of the adult herd is infected. Using the flow chart (Figure 3) it is likely that the control option for a medium/high prevalence herd (with bio-exclusion, vaccination and monitoring) is the most appropriate.

Testing more or less than the numbers in the table

If a farmer tests more or fewer than the numbers shown in the table, then the accuracy of the result will increase or decrease according- see Table 5. Following from the example above, if the farmer had tested only 25 cattle and found 16 positive (a prevalence of 60%) he/she knows that the true prevalence (again with 95%) confidence) is between 50 and 70% (60+/-10%).

Table 5 gives examples of this for various herd sizes tested by the gB ELISA on blood, again with a 95% confidence in your result (e.g. the true prevalence will lie within the range indicated by the test 95 times out of 100).

Accuracy range	Herd Size					
	<25	25-35	36-50	51-75	76-125	126-175
+/- 2%	All	34	48	70	111	148
+/- 5%	21	29	38	50	68	81
+/- 10%	15	18	22	25	29	31
+/- 20%	7	8	8	9	9	9

Table 5. Testing higher or lower numbers from a herd increases or decreases accuracy respectively.

The table was produced using the assumed test characteristics shown on **Q8 'What tests are available to investigate IBR?'** and the epidemiological tool available at: http://epitools.ausvet.com.au/content.php?page=PrevalenceSS

Testing all animals in a herd

All animals should be tested to identify any latently infected animals. This is most appropriate for herds that appear to have a very low prevalence, either after a bulk milk screening test or after testing a proportion of the herd as indicated above, with the goal of identifying any latently infected animals.

Monitoring Testing

All negative herds/low prevalence herds

Test regularly (annual or bi-annual) to confirm a low prevalence. This is best done by testing all animals but in larger herds it can also be done using blood tests by testing a reduced number to save money. Table 6 can be used to select an appropriate number of animals to test. When appropriate numbers are tested and no positive results obtained, this result indicates that less than 5% of the herd are infected, and will be correct 95% of the time (95% herd sensitivity).

Therefore, even where all samples test negative, this is not an absolute guarantee that all animals are truly negative. Also, where herds are truly negative there may be incidences of small numbers of 'false positives' identified.

	Herd size						
	<100	100-150	150-200	201-250	251-300	301-400	>401 (500)
gB Blood	77	82	109	117	116	119	121
Cut-point positives	2	2	3	3	3	3	3
gE Blood	80	102	113	121	120	124	126
Cut-point positives	2	3	3	3	3	3	3

Table 6. Monitoring a low prevalence/all negative large herd by testing an appropriate number of animals.

[1] Add an additional 2 animals to the test for every 100 extra in the herd (cut remains 3 or 4 as shown);

The table was produced using the assumed test characteristics shown on **Q8 'What tests are available to investigate IBR?'** and the epidemiological tool available at: http://epitools.ausvet.com.au/content.php?page=FreeCalc2

If you identify small numbers of test positive animals in your herd when you think you are free from infection, it may be worth re-testing the individuals involved to reduce the chance that the test result is 'false positive'. If results indicate only 2 or 3 animals are positive (on gB blood tests) or 3 or 4 are positive (on the gE blood test), it is important to follow up with further individual testing as these may be 'false positives'.

In addition to blood testing, dairy herds can monitor low prevalence status using repeated bulk milk antibody tests, which would be expected to be negative in entirely negative herds. Remember though that herds with a low prevalence of infection (<10-15%) can have repeated negative tests in the absence of virus circulation.

Moderate/high prevalence herds

Test regularly to make sure vaccination is reducing spread. This is best done by testing young animals that were born or entered the adult herd after the comprehensive vaccination programme began. For example, the first year after vaccinating test weanlings (at least 6 months old) born since the start of vaccination; in the second year, test this year's weanlings and the one to two year olds etc. The number and age of animals being monitored will therefore increase each year.

If you do not want to test test all animals in these age groups, use Table 4 to select an appropriate number to test. In this case, use the total number of eligible animals in the group (e.g. young stock 6-12 months in the first year after vaccinating) as the 'herd size'. Ideally, a successful vaccination programme will prevent the spread of virus to these animals, with this being demonstrated by negative test results. In addition, repeating an investigation test of the entire herd (as shown in Table 4) to monitor herd prevalence should indicate that the within herd prevalence is reducing with time.

Remember that any monitoring test result is only valid on the day the animals have been sampled; any action that might introduce new infection (such as purchasing stock) may change the herd status quickly.

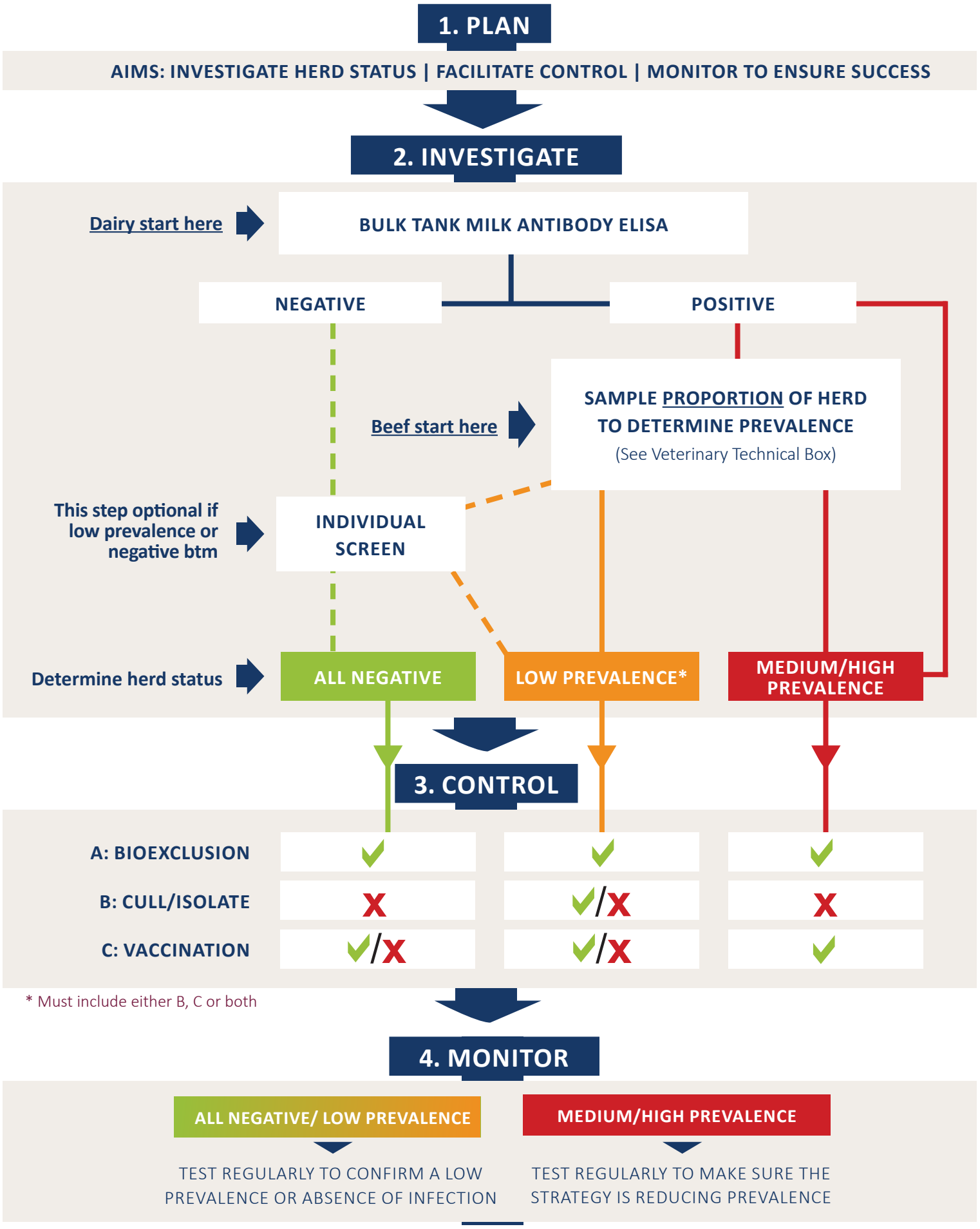

Figure 3. Planning, investigating, controlling and monitoring tool for IBR.

Q10 How do I decide whether to start a control programme for IBR in a herd?

Evaluate your herd

Knowledge of the impact that IBRV is having in your herd and on any future herd goals is helpful in deciding whether or not to invest in a control programme. When the likely or potential costs of IBRV in your herd outweigh the cost of implementing controls, then investing in control is appropriate. It may be helpful to read **Q6 'What are the likely consequences of having IBR infected animals in a herd?'** before reading this section.

There are three areas that are useful to consider when assessing the impact IBRV may be having on your herd:

- Specific herd goals.
- Clinical impact.
- Sub-clinical impact.

Specific herd goals

Focusing on herd owners' specific goals and how IBR might impact on these (even when the infection is sub-clinical) will influence whether or not a herd owner commences a control and monitoring programme. Herd goals may include:

- To sell animals into semen collection centres or bull testing stations.
- To sell breeding heifers or cows into other herds.
- To export animals to countries within the EU with officially recognised IBR freedom or control programmes (currently Denmark, Germany, regions of Italy, Austria, Finland, Sweden, Belgium, Luxembourg, regions of Italy and the Czech Republic) or other IBR free states (Norway, Switzerland).
- To sell commercial stock as IBR free.
- To obtain or maintain a high herd health status.

When these are specific herd goals then starting a control programme would be warranted. See **Q3 'How does IBR affect an individual animal?'** for more information on clinical signs.

Clinical impact

When herds are experiencing clinical signs associated with IBRV the cost to the herd, in terms of both loss of production and animal welfare can be substantial *(Sayers, 2017; EFSA, 2006; Wiseman et al., 1978)*. A control programme in such circumstances would almost always be warranted.

Sub-clinical impact

Some IBRV infected herds have no observed clinical signs associated with the infection. The impact that IBRV is having in such herds is much more difficult to assess. In some cases it is difficult to establish the extent of any loss of production *(Hage et al., 1998; Muylkens et al., 2007; Pritchard et al., 2003)*. Careful consideration of current herd performance is required. If there is a concern that performance is being negatively affected by IBR then a control programme should be considered.

Next steps...

If you decide to start a control programme then assessing the current status with a herd test is helpful. A control programme that is appropriate for your herd can be designed once the current impact and herd status are known. See **Q9 'How do I test a herd for IBR?'** for more information on herd testing. See **Q11 'What different options are available to control IBR in a herd?'** for more information on implementing a control programme.

Q11 What different options are available to control IBRV in a herd?

Three components of control

There are 3 principles that are commonly implemented to control IBRV in herds, but not all must be used in every herd. The three components are:

- Bio-exclusion- stopping the virus from coming into your herd.
- Isolation/culling of latent carriers.
- Vaccination of the herd.

The best control strategy will vary with your herd status (all negative, low prevalence or medium/high prevalence). Table 7 summarises the principles that should be applied in each of these situations.

Control principles	All negative herd	Low prevalence herd*	Medium or high prevalence herd
A. Bioexclusion	✓	✓	✓
B. Cull/Isolate	X	✓/X	X
C. Vaccination of the herd	✓/X	✓/X	✓

Table 7. Selecting appropriate methods of control should be based on current herd status
*Must include either B, C, or both.

Whatever strategy you decide is most appropriate for you, it is best to work with your veterinary practitioner to regularly monitor your herd to ensure that the control is working. See below and **Q9 'How do I test a herd for IBR?'** for more details on how to monitor your control programme.

Bio-exclusion

Bio-exclusion means stopping disease coming into your herd from outside your herd. It is an essential component of all disease control programmes *(EFSA, 2006)*. The biggest risk comes from animals introduced to a herd (purchased, borrowed, contract reared heifers, stock returning from shows and sales). If you are purchasing stock regularly you remain at higher risk of bringing IBR into your herd. See the Animal Health Ireland Biosecurity Leaflet on **Purchasing stock: Reducing Disease Risks**. Neighbouring stock and contaminated visitors or equipment also pose a significant risk. See Table 5 for other bio-exclusion risks for IBRV.

Vaccination alone will not prevent introduction of IBR into your herd. In test negative herds (no test positive animals after carrying out screening on each individual animal) bio-exclusion is the only principle that must be applied. Vaccination (see below) can be included as an additional option to reduce the risk associated with future breakdowns in biosecurity.

Culling/isolation test positive animals

In herds with very few latent carriers or in herds that wish to achieve IBR freedom or stop spread very quickly, culling/isolation of latent carriers may be appropriate. In doing so, the risk of spread from infected animals can be reduced very rapidly. The long term isolation option requires great discipline and effort and may not be practical in many herds.

In low prevalence herds culling/isolation can be used in addition to bio-exclusion to achieve rapid removal of the virus. Vaccination (see below) can be included as an alternative or additional option in these herds.

Vaccination of the herd

Complete and regular herd vaccination (consistent with the manufacturers' instructions and your own veterinary practitioner's advice) is the most commonly used method to control IBR. The vaccine makes it less likely that a latent carrier will reactivate and shed the virus, and less likely that a naïve animal will become ill and spread the virus after exposure. It has the advantage of not necessarily requiring the identification, culling/isolation of latent carriers early in the control programme. Vaccination of IBR test negative herds can also be done to reduce the impact from a re-introduction of the virus (e.g. from a bio-exclusion breakdown) *(EFSA, 2006)*.

In medium or high prevalence herds vaccination with bio-exclusion is the most practical and appropriate control option.

It is likely that bio-exclusion and vaccination will need to be used for a period of years before an infected herd achieves a low prevalence or becomes test-negative. There is a limited amount of published evidence to suggest that:

- Live vaccines offer both better protection against clinical signs and a reduction of viral shedding in newly infected animals than inactivated vaccines.
- During an outbreak, live vaccines offer faster protection against clinical signs when used intranasally.
- Inactivated (killed, dead) vaccines are more effective at reducing viral shedding by latently infected animals than live vaccines.

Always follow manufacturers' guidelines and advice on vaccine usage *(Bosch et al., 1996; Bosch et al., 1997; Kaashoek et al., 1996)*. See **Q12 'What types of vaccines are available against IBR?'** for more detail on types of vaccine.

Monitor Progress

All control programmes should be monitored to make sure they are working. If monitoring tests indicate lack of progress, contact your own veterinary practitioner in order to reassess your control programme. The most appropriate monitoring depends on your herd status (all test negative, low prevalence or medium/high prevalence). Be aware of the clinical signs of IBR (see earlier) and have any suspicious cases examined by your own veterinary practitioner.

Herds with a low prevalence of infection or all animals tested negative

Test regularly to confirm the herd status (once or twice per year). This is best done by testing all animals, though in some circumstances a reduced number can be tested. See **Q9 'How do I test a herd for IBR?'** for more details.

Bulk Milk Testing

Regular bulk milk tank (BMT) antibody tests may also be used in test negative/low prevalence herds to monitor their status. Antibody levels in the bulk milk will increase if the virus starts spreading within the milking herd. A positive bulk tank milk result will be obtained in herds with moderate to high prevalence of latently infected animals, ongoing circulation of the virus or herds that have recently been vaccinated (depending on the vaccine and test used).

NOTE: A negative bulk milk result can be obtained in herds with up to 10-15% of the milking cows latently infected. Therefore, a negative result cannot be interpreted as indicating a disease free herd.

Medium/High prevalence herds

Test regularly to make sure vaccination is reducing spread. This is best done by testing younger animals that have been in the herd only since a comprehensive vaccination programme (according to the manufacturer's instructions) has been in place. Ideally, a successful vaccination programme will stop the spread of infection in the herd, so that animals born after the start of the programme should remain uninfected and antibody-negative.

For example, in the first year test weanlings (at least 6 months old) born since the start of vaccination; in the second year after vaccinating test weanlings and the one to two year olds etc. The number and age of animals being monitored will therefore increase each year.

In addition, repeating the investigation test to monitor herd prevalence (see above) should indicate that the within herd prevalence is reducing with time, with bulk tank milk eventually becoming negative. All control programmes should be monitored to make sure they are working. The most appropriate monitoring depends on your herd status (all negative, low prevalence or medium/high prevalence).

Q12 What types of vaccines are available against IBR?

Vaccines improve immunity

A vaccine is a substance that improves the immunity of an animal against an infectious disease. When vaccinated against IBRV an animal will:

- *Show less* clinical signs during primary infection.
- *Shed less* virus during primary and secondary infections, and following reactivation.

NOTE: A vaccinated animal can still become infected when exposed to field virus, become a latent carrier of that virus and become positive on a blood test *(Muylkens et al., 2007).*

All vaccinations should be used in accordance with manufacturers' instructions, particularly recommendations on storage, transport, reconstitution (mixing), timing, age of vaccination and correct use of booster vaccinations. See **Q3: 'How does IBR affect an individual animal?'** for more information on latent infections.

Types of IBR vaccine

There are different types of vaccine that can improve an animals' immunity against IBR *(van Drunen Littel-van den Hurk, 2006)* . The differences are based on:

- If the vaccine is 'Marker' or 'Conventional' (Non-Marker).
- If the vaccine contains live inactivated/killed/dead virus.

NOTE: Animals must not be vaccinated with any type of vaccine (including 'Marker' vaccines) if they are to enter a semen collection centre or bull testing station in the Republic of Ireland.

Marker and Conventional (Non-Marker) vaccines

An IBR vaccine can either be 'Conventional' (Non-Marker) or 'Marker'. Only 'Marker' vaccines are licensed for use in the Republic of Ireland.

Conventional (Non-Marker)

Only 'Marker' vaccines are licensed for use in the Republic of Ireland. When a 'Conventional' (Non-Marker) vaccine is used there is no way to determine whether a vaccinated animal has been naturally infected with IBR. This is a problem when trying to control IBR because you cannot identify animals latently infected with natural virus in vaccinated stock or track the success of a control programme *(van Drunen Littel-van den Hurk, 2006)*.

Marker

'Marker' vaccines were developed to allow vaccinated and naturally infected (or conventionally vaccinated) animals to be differentiated using an appropriate test (gE specific). The success of control programmes using 'Marker' vaccine can be monitored easily.

NOTE: Only 'Marker' vaccines are licensed for use in the Republic of Ireland.

In other countries (including the United Kingdom) both 'Conventionally' (Non-Marker) and and 'Marker' vaccines are available. The 'Marker' vaccine companion tests are a little less reliable than general tests. See **Q8: 'What tests are available to investigate IBR?'** for more information on testing an animal for IBR.

NOTE: Animals must not be vaccinated with any type of vaccine (including 'Marker' vaccines) if they are to enter a semen collection centre or bull testing station in the Republic of Ireland.

Live and inactivated vaccines

All IBR vaccines contain virus that act to stimulate the animals' immune system *(van Drunen Littel-van den Hurk, 2006)*. The virus used in these vaccines can be either live or killed.

Live vaccines

In some IBR vaccines the virus is still alive although it does not cause clinical signs (it is *live* but *attenuated*). Live IBR vaccines can be given intra-nasally to allow a more rapid onset of immunity than when given intramuscularly *(EFSA, 2006; Kaashoek et al., 1996; van Drunen Littel-van den Hurk, 2006)*.

There is a risk that live vaccines can spread to other animals after intranasal use and some may establish latent infection. However, a European Food Safety Authority report considers it unlikely that live vaccine virus will perpetuate in cattle populations *(EFSA, 2006)*.

NOTE: The risk of spread of live vaccine to non-vaccinated animals (especially when given intra-nasally to animals in the same cohort) should be considered if they may subsequently seek entry to a semen collection centre or bull testing station.

Inactivated (killed) vaccines

In other IBR vaccines, the virus has been inactivated. Inactivated vaccine virus cannot establish a latent infection or spread to other animals in the herd *(EFSA, 2006; van Drunen Littel-van den Hurk, 2006)*. Inactivated vaccines should not be administered by the intra-nasal route, but are given either intramuscularly or subcutaneously (check the manufacturers' instructions).

Comparing live and killed vaccines

It is not possible at this time to conclusively recommend the use of either the live or killed vaccine as the product of choice in every herd, and some vacccine strategies now involve the use of both live and dead vaccines at different times. It is currently generally accepted that:

- Both reduce clinical signs during primary infection.
- Both reduce shedding during primary infection.
- Both reduce, but do not prevent, spreading in the field.
- Neither prevent development of latent infection following exposure to field virus.

(Bosch et al., 1998; EFSA, 2006; Kaashoek et al., 1994; Kaashoek et al., 1996; Mars et al., 2001)

In addition, there is limited evidence to suggest that:

- Live vaccines offer both better protection against clinical signs and a reduction of viral shedding in newly infected animals than inactivated vaccines *(Bosch et al., 1996)*.
- During an outbreak, live vaccines offer faster protection against clinical signs when used intranasally.
- Inactivated (killed, dead) vaccines are more effective at reducing viral shedding by latently infected animals than live vaccines *(Bosch et al., 1997)*.

See **Q13: 'How do I decide whether to vaccinate a herd for IBR?'** for more information on using IBR vaccinations.

Q13 How do I decide whether or not to vaccinate a herd for IBR?

Vaccination to aid control

Vaccination is commonly used as part of herd control programmes against IBR. See **Q10: 'How do I decide whether to start a control programme for IBR in a herd?'** for advice on the benefits of IBR control at the herd level.

If you have already decided to start a herd control programme, vaccination can be used in different ways to achieve different goals, or may not be required at all. See **Q11: 'What different options are available to control IBR in a herd?'** for more information on control programmes.

The various uses of vaccination as part of control programmes are also outlined below.

Different uses of vaccination in herd control

To reduce clinical signs

Vaccination can be used to reduce the clinical impact of IBR *(EFSA, 2006)*. In these circumstances it may be possible to only vaccinate the group currently experiencing a clinical outbreak. Live vaccines administered intra-nasally offer faster protection against clinical signs of IBR, including in the face of an outbreak. Evidence suggests that live vaccines offer better protection against clinical signs of IBR than inactivated vaccines *(Bosch et al., 1996; Kaashoek and van Oirschot, 1996)*.

To reduce reactivation and spread from latent carriers

Vaccination can also be used to reduce the reactivation and spread of virus when trying to reduce the number of latent carriers in a herd. This requires maintenance of a high level of immunity in both latently infected and naïve animals. To achieve this, complete and regular herd vaccination (consistent with the manufacturers' instructions) is required. There is some evidence to suggest that killed vaccines are more effective at limiting reactivation and shedding in latently infected animals *(Bosch et al., 1997)*.

To provide herd immunity

In herds that are already IBR free vaccination may be used to provide some protection against infection. This offers the advantages of reducing the potential impact of a subsequent breakdown of bio-exclusion. As above, complete and regular herd vaccination (consistent with the manufacturers' instructions) is required. See **Q12: 'What types of vaccines are available against IBR?'** for more information on live and killed vaccines.

Q14 What is the risk of introducing IBR with semen purchased from an AI centre?

Risk from semen originating in the Republic of Ireland is negligible

Although semen is a known route by which IBR can be transmitted:

- All cattle entering semen collection centres in the Republic of Ireland must test negative for IBR.
- The risk can therefore be considered as negligible *(EFSA, 2006)*.

Legally imported semen must also come from IBR free collection centres and the risk from such imported semen can also be considered as negligible *(EFSA, 2006)*. The legislation governing these requirements is outlined in EU council directive 2003/43/EC and enforced in Ireland as described in SI 112/1996 (as amended). Importing any bull of unknown status into a herd is a higher risk activity than importing semen for AI.

Risk from semen originating outside the Republic of Ireland

Other countries within the EU (including the United Kingdom) have allowed semen collection centres to operate without IBR freedom, provided that the semen is used for domestic trade only *(DEFRA, 2007)*.

NOTE: Semen from such collection centres cannot be legally imported into the Republic of Ireland.

NOTE: Semen from these collection centres presents a greater risk for introducing IBR into a herd *(EFSA, 2006)*.

Semen legally imported from these countries meets EU standards and presents a negligible risk.

Q15 Can humans be affected by IBR?

IBR is not a disease of humans

The IBR virus (BoHV-1) has never been reported to cause disease in humans *(ANON, 2006)*.

Q16 Is there a national programme for IBR control in Ireland?

No national control programme

Several EU Member States, or regions thereof, are considered free of IBR, including Denmark, Germany, Italy (the Province of Bolzano and the Region Valle d'Aosta), Austria, Finland, and Sweden *(2004/558/EC as amended)*. Norway and Switzerland are also considered IBR free.

In addition, several EU Member States, or regions thereof, have EU approved programmes for the control and eradication of BoHV-1, including Czech Republic, Belgium, and Italy (the Autonomous Region of Friuli Venezia Giulia, the Autonomous Province of Trento) *(2004/558/EC as amended)*. Several other European countries have national control programmes that are not yet recognised by EU legislation (the Netherlands, France, Spain, Hungary and Slovakia).

The benefits of eradicating IBR would include elimination of clinical and sub-clinical disease, improving animal welfare, as well as substantially extending the genetic pool of animals available for entry into semen collection centres.

Animal Health Ireland is currently working with all industry stakeholders to investigate options for a national approach to IBR control.

All References

ANON 2006, The biology of bovine herpesvirus 1 (Australian Government, Office of the Gene Technology Regulator).

Banks, M., Ibata, G., Murphy, A.M., Frossard, J.P., Crawshaw, T.R., Twomey, D.F., 2008, Bovine lymphotropic herpesvirus and non-responsive post-partum metritis in dairy herds in the UK. The Veterinary Journal 176, 248-250.

Barrett, D., Parr, M., Fagan, J., Johnson, A., Tratalos, J., Lively, F., Diskin M., Kenny, D. 2018, Prevalence of Bovine Viral Diarrhoea Virus (BVDV), Bovine Herpes Virus 1 (BHV 1), Leptospirosis and Neosporosis, and associated risk factors in 161 Irish beef herds. *BMC Veterinary Research, 14*(1), 8. https://doi.org/10.1186/s12917-017-1324-9]

Bosch, J.C., De Jong, M.C.M., Franken, P., Frankena, K., Hage, J.J., Kaashoek, M.J., Maris-Veldhuis, M.A., Noordhuizen, J.P.T.M., Van der Poel, W.H.M., Verhoeff, J., Weerdmeester, K., Zimmer, G.M., Van Oirschot, J.T., 1998, An inactivated gE-negative marker vaccine and an experimental gD-subunit vaccine reduce the incidence of bovine herpesvirus 1 infections in the field. Vaccine 16, 265-271.

Bosch, J.C., Kaashoek, M.J., Kroese, A.H., van Oirschot, J.T., 1996, An attenuated bovine herpesvirus 1 marker vaccine induces a better protection than two inactivated marker vaccines. Veterinary Microbiology 52, 223-234.

Bosch, J.C., Kaashoek, M.J., van Oirschot, J.T., 1997, Inactivated bovine herpesvirus 1 marker vaccines are more efficacious in reducing virus excretion after reactivation than a live marker vaccine. Vaccine 15, 1512-1517.

Christensen, J., Gardner, I.A., 2000, Herd-level interpretation of test results for epidemiologic studies of animal diseases. Preventive Veterinary Medicine 45, 83-106.

Cowley, D.B., Clegg, T., Doherty, M., More, S., 2011, Aspects of bovine herpesvirus-1 infection in dairy and beef herds in the Republic of Ireland. Acta Veterinaria Scandinavica 53, 40.

DEFRA, 2007, Explanatory memorandum to the bovine semen (England) regulations 2007. 1319.

Dennett, D.P., Barasa, J.O., Johnson, R.H., 1976, Infectious bovine rhinotracheitis virus: studies on the venereal carrier status in range cattle. Res Vet Sci 20, 77-83.

EFSA, 2006, Definition of a BoHV-1-free animal and a BoHV-1- free holding, and the procedures to verify and maintain this status European Food Safety Authority 311, 1-65.

Geraghty, T., O'Neill, R., More, S.J., O'Grady, L., 2012, Dynamics of individual animal Bovine Herpes Virus-1 antibody status on 9 commercial dairy herds. Research in Veterinary Science 93, 143-149.

Givens, M.D., Marley, S.D., 2008, Approaches to biosecurity in bovine embryo transfer programs. Theriogenology 69, 129-136.

Hage, J.J., Schukken, Y.H., Barkema, H.W., Benedictus, G., Rijsewijk, F.A.M., Wentink, G.H., 1996, Population dynamics of bovine herpesvirus 1 infection in a dairy herd. Veterinary Microbiology 53, 169-180.

Hage, J.J., Schukken, Y.H., Dijkstra, T., Barkema, H.W., van Valkengoed, P.H.R., Wentink, G.H., 1998, Milk production and reproduction during a subclinical bovine herpesvirus 1 infection on a dairy farm. Preventive Veterinary Medicine 34, 97-106.

Kaashoek, M.J., Moerman, A., Madic, J., Rijsewijk, F.A.M., Quak, J., Gielkens, A.L.J., van Oirschot, J.T., 1994, A conventionally attenuated glycoprotein E-negative strain of bovine herpesvirus type 1 is an efficacious and safe vaccine. Vaccine 12, 439-444.

Kaashoek, M.J., Rijsewijk, F.A.M., Van Oirschot, J.T., 1996, Persistence of antibodies against bovine herpesvirus 1 and virus reactivation two to three years after infection. Veterinary Microbiology 53, 103-110.

Kaashoek, M.J., van Oirschot, J.T., 1996, Early immunity induced by a live gE-negative bovine herpesvirus 1 marker vaccine. Veterinary Microbiology 53, 191-197.

Kramps, J.A., Banks, M., Beer, M., Kerkhofs, P., Perrin, M., Wellenberg, G.J., Oirschot, J.T.V., 2004, Evaluation of tests for antibodies against bovine herpesvirus 1 performed in national reference laboratories in Europe. Veterinary Microbiology 102, 169-181.

Mars, M.H., de Jong, M.C.M., Franken, P., van Oirschot, J.T., 2001, Efficacy of a live glycoprotein E-negative bovine herpesvirus 1 vaccine in cattle in the field. Vaccine 19, 1924-1930.

Mars, M.H., de Jong, M.C.M., van Maanen, C., Hage, J.J., van Oirschot, J.T., 2000, Airborne transmission of bovine herpesvirus 1 infections in calves under field conditions. Veterinary Microbiology 76, 1-13.

Miller, J.M., Van der Maaten, M.J., 1986, Experimentally induced infectious bovine rhinotracheitis virus infection during early pregnancy: effect on the bovine corpus luteum and conceptus. Am J Vet Res 47, 223-228.

Mollema, L., Rijsewijk, F.A.M., Nodelijk, G., de Jong, M.C.M., 2005, Quantification of the transmission of bovine herpesvirus 1 among red deer (*Cervus elaphus*) under experimental conditions. Veterinary Microbiology 111, 25-34.

Muylkens, B., Thiry, J., Kirten, P., Schynts, F., Thiry, E., 2007, Bovine herpesvirus 1 infection and infectious bovine rhinotracheitis. Veterinary Research 38, 181-209.

Nylin, B., Stroger, U., Ronsholt, L., 2000, A retrospective evaluation of a Bovine Herpesvirus-1 (BHV-1) antibody ELISA on bulk-tank milk samples for classification of the BHV-1 status of Danish dairy herds Preventive Veterinary Medicine 47, 91-105.

O'Grady, L., O'Neill, R., Colins, D.M., Clegg, T.A., More, S.J., 2008, Herd and within-herd BoHV-1 prevalence among Irish beef herds submitting bulls for entry to a performance testing station. Irish Veterinary Journal 61, 809-815.

OIE, 2010, Infectious Bovine Rhinotracheitis/Infectious Pustular Vulvovaginitis. OIE Terrestrial Manual.

Pritchard, G.C., 1998, Elimination of infectious bovine rhinotracheitis virus infection from a heavily infected dairy herd. World Buiatrics Congress 19, 49 - 53.

Pritchard, G.C., Banks, M., Vernon, R.E., 2003, Subclinical breakdown with infectious bovine rhinotracheitis virus infection in dairy herd of high health status. Veterinary Record 153, 113-117.

Probst, U., Wyler, R., Kihm, U., Ackermann, M., Bruckner, L., Muller, H.K., Ehrensperger, F., 1985, [Excretion of IBR virus, especially in milk, in experimentally infected cows]. Schweiz Arch Tierheilkd 127, 723-733.

Radostits, O.M., Gay, C.C., Hinchcliff, K.W., Constable, P.D. 2007, Infectious Bovine Rhinotracheitis Infection. In Veterinary Medicine (Philadelphia, Saunders Elsevier), pp. 1349-1361.

Sayers, 2017, Associations between exposure to bovine herpesvirus 1 (BoHV-1) and milk production, reproductive performance, and mortality in Irish dairy herds, Journal of Dairy Science,]100:1340–1352]

Taylor, R., Seal, B., St Jeor, S., 1982, Isolation of infectious bovine rhinotracheitis virus from the soft-shelled tick, *Ornithodoros coriaceus*. Science 216, 300-301.

Thiry, E., Saliki, J., Bublot, M., Pastoret, P.P., 1987, Reactivation of infectious bovine rhinotracheitis virus by transport. Comparative Immunology, Microbiology and Infectious Diseases 10, 59-63.

Thiry, E., Saliki, J., Schwers, A., Pastoret, P.P., 1985, Parturition as a stimulus of IBR virus reactivation. Veterinary Record 116, 599-600.

Thiry, J., Keuser, V.r., Muylkens, B.t., Meurens, F.o., Gogev, S., Vanderplasschen, A., Thiry, E., 2006, Ruminant alphaherpesviruses related to bovine herpesvirus 1. Vet. Res. 37, 169-190.

van Drunen Littel-van den Hurk, S., 2006, Rationale and perspectives on the success of vaccination against bovine herpesvirus-1. Veterinary Microbiology 113, 275-282.

van Nieuwstadt, A.P., Verhoeff, J., 1983, Epidemiology of BHV 1 virus infections in dairy herds. Journal of Hygiene 91, 309-318.

van Schaik, G., Nielen, M., Dijkhuizen, A.A., 2001a, An economic model for on-farm decision support of management to prevent infectious disease introduction into dairy farms. Preventive Veterinary Medicine 51, 289-305.

van Schaik, G., Schukken, Y.H., Nielen, M., Dijkhuizen, A.A., Benedictus, G., 2001b, Risk factors for introduction of BHV1 into BHV1-free Dutch dairy farms: a case-control study. Vet Q 23, 71-76.

VLA, V.L.A., 2011, Infectious bovine rhinotracheitis outbreaks in dairy cows. Vet Rec 168, 71-74.

Wellenberg, G.J., Verstraten, E.R.A.M., Mars, M.H., Oirschot, J.T.V., 1998, ELISA detection of antibodies to glycoprotein E of bovine herpesvirus 1 in bulk milk samples. Veterinary Record 142, 219-220.

Wiseman, A., Msolla, P.M., Selman, I.E., Allan, E.M., Cornwell, H.J., Pirie, H.M., Imray, W.S., 1978, An acute severe outbreak of infectious bovine rhinotracheitis: clinical, epidemiological, microbiological and pathological aspects. Vet Rec 103, 391-397.

Wiseman, A., Selman, I.E., Msolla, P.M., Pirie, H.M., Allan, E., 1979, The financial burden of infectious bovine rhinotracheitis. Vet Rec 105, 469.

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