

Better management of Bovine Respiratory Disease

(BRD/pneumonia)

Key Messages

- Managing the animal-environment-pathogen interaction is key to controlling BRD
- An adequate intake of colostrum as soon after birth as possible is essential to combat disease
- The performance of calves will be lower the more stress put on them
- Plan a strategy with your vet that will reduce stress at weaning
- Strict biosecurity is required to manage the risks of purchased cattle
- Vaccination against the four key viruses can dramatically reduce outbreaks
- Moisture levels, air quality and air speed in a building can significantly affect the prevalence and severity of BRD
- Buildings need a roof outlet to release warm, moist, foul air
- The inlet area needs to be a minimum of twice the outlet area but ideally four times
- Floors must be safe, durable and carry liquid away from the animals
- Straw choppers should not be operated in buildings with stock below three months of age
- There should be zero tolerance to poor hygiene for youngstock
- *Mycoplasma* spp. are widespread and often involved in causing BRD. There is no vaccine and success of treatment is threatened by increasing antimicrobial resistance



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Photos courtesy of RAFT solutions, Synergy Farm Heath Ltd, Jamie Robertson, Bishopton Veterinary Group and Alex Corbishley.

Introduction

Bovine respiratory disease (BRD) or pneumonia is common in commercially reared beef calves and yearlings. It causes inflammation of the lung tissue and airways, and damage may be irreversible in severe cases.

Pneumonia is one of the most significant diseases affecting English beef producers, costing the UK cattle industry an estimated £50 million a year. It is the most common reason for death and poor performance in young cattle from weaning to 10 months of age.

Cattle succumb when the disease pressure overcomes their immune system. Strategies to reduce pneumonia should therefore target improving cattle immunity and reducing stress, as well as treating any concurrent disease present.

Studies have shown that when 30 per cent of cattle in a group show actual signs of respiratory disease, a further 40 per cent can exhibit lung damage at slaughter. Therefore, it is likely that many cases go unnoticed, yet cause significant performance loss.

A large proportion of the costs associated with pneumonia are hidden, such as reduced liveweight gain and feed conversion efficiency (FCE).

Costs per affected animal range between £30–£80, but increase to £500 or more if an animal dies because of the disease.

Impacts of BRD on a beef enterprise include:

- Failure to reach growth targets
- High vet costs due to secondary infections, usually bacterial
- An additional 14 days taken to reach breeding weights
- Average daily liveweight gains reduced by up to 0.2kg/day
- Increased days to slaughter and poorer carcase classification
- Increased mortality and culling
- Increased replacement costs due to culling of young breeding animals
- Risk of bringing in disease with purchased cattle

Mortality in the grower/finisher stages represents the maximum financial loss per beef animal, because a great deal of time and money have been invested in the animal for no return. While numbers are not high, the risk of losses in 12–18 month cattle increases if animals have been infected as young calves.

Recognising BRD



Affected animals may breathe heavily, cough, have a nasal discharge and look depressed

BRD is a complex multifactorial disease. Although the symptoms are obvious in more severely affected animals, often the whole group may be affected subclinically, which only shows through reduced feed intake, growth rates and FCE.

The symptoms of BRD are:

- Reduced feeding
- Raised temperature (above 39.4°C or 103°F)
- Increased breathing rate and effort
- Head down and looking depressed
- Coughing
- Nasal discharge (clear mucus initially, may become thick and purulent with time and secondary infection)
- Death

Testing for disease

It is not possible to determine which pathogens (viruses and bacteria) are causing disease without testing. There are two scenarios when knowing this information is particularly useful:

During a disease outbreak, to determine the most appropriate response

- In this instance, the priority is to get an answer quickly
- A vet will take samples from the respiratory tract of a number of untreated animals. This may include washing out the calf's lungs (broncho-alveolar lavage), taking swabs from the nose (naso-pharyngeal swabs) or lung samples from dead calves
- The best animals to sample are those who have only just become unwell as these animals will not yet have a secondary infection
- Within two to five days of arriving at the laboratory, these samples will be tested for the most common viruses (IBR, PI3 and RSV*) and any relevant bacteria identified (cost in 2017 ~ £50/calf)
- If IBR is present, then vaccination during the outbreak may be an option
- Most importantly, any bacteria identified will be tested for antibiotic resistance, hence allowing selection of the most appropriate antibiotic. This will avoid wasted time and money using drugs that may not be effective
- It is possible to take blood samples from affected animals at the time of sampling the respiratory tract and again two weeks later
- Blood samples are tested for antibodies (paired serology) and can help to build a picture of the involvement of up to six of the most common viruses, including Bovine Viral Diarrhoea (BVD), and bacteria
- It usually takes two weeks after the second sample for these results to be available and therefore the information is usually used to guide future vaccination decisions, rather than the initial response to the outbreak

* Infectious Bovine Rhinotracheitis, Parainfluenza 3 virus, Respiratory Syncytial Virus

In a closed herd, to design future vaccination strategies

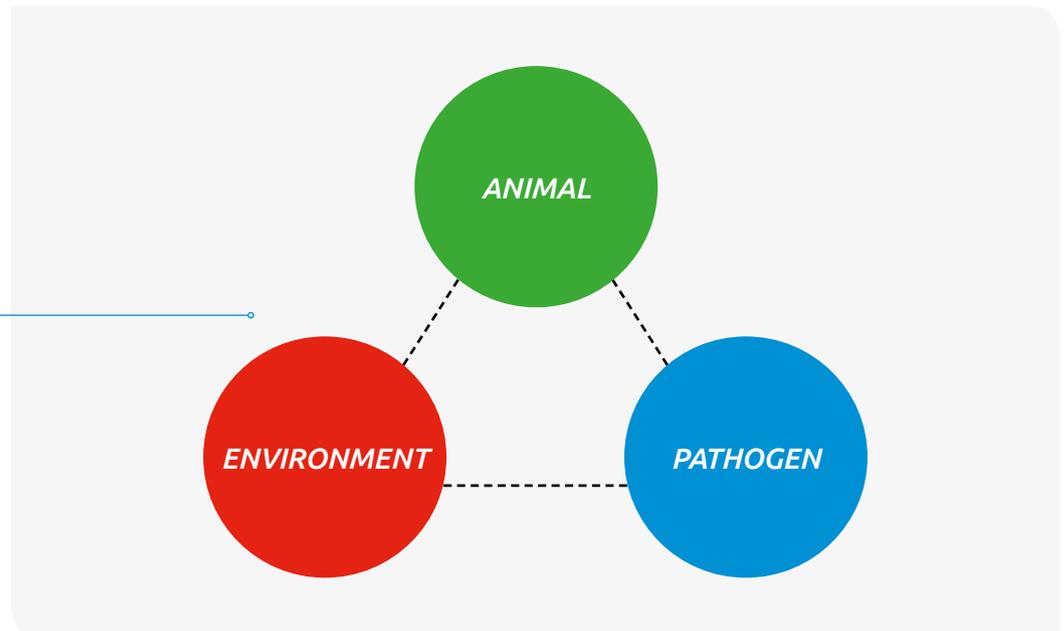
- In this instance, a single blood sample from a number of six-to-nine month old animals at the end of housing is usually sufficient
- These blood samples are usually tested for antibodies against the six most common viruses and bacteria
- This information can then be used to design suitable vaccination protocols. However, if animals are bought in, the disease picture on the farm could change

Preventing and controlling BRD

A fundamental appreciation of the animal-pathogen-environment interactions is key to understanding the success or failure of control strategies.

Managing just one of these issues in isolation will not prevent or control the disease – they must be tackled together.

Managing the animal-environment-pathogen interaction is key to preventing controlling BRD.



BRD occurs when the challenge of infection from pathogens overwhelms the immune defences of the animal. Many factors influence this, including many non-specific stressors, such as:

Nutrition

- Colostrum intake at birth
- Nutritional requirements for growth
- Trace element status, especially vitamin E/selenium

Stress

- At weaning
- During castration/disbudding
- In transport

Exposure to disease

- Mixing/changing groups
- High stocking rates

Environment

- Inadequate environment, eg poor air quality, wet bedding, draughts at animal level
- Temperature variation and extremes

Concurrent disease

- Bovine Viral Diarrhoea (BVD), coccidiosis and heavy parasite burdens (fluke and worms), for example

Animal

Species differences

Cattle have small lungs relative to body size when compared with other mammals. This may decrease their resistance to respiratory infection, particularly in fast-growing cattle, which have high metabolic requirements relative to their lung capacity. There is also a risk of a rapid increase in stocking rate as they grow and become bigger and heavier.

Colostrum management

Calf health hinges significantly on the provision of adequate amounts of good-quality colostrum at birth. Passive immunity is passed from mother to calf through her milk, providing the only means of protecting the newborn against disease.

An adequate intake of colostrum as soon after birth as possible is essential to combat disease.

The effectiveness of colostrum is determined by the quality, quantity consumed and how quickly the calf receives it. Calf vigour is particularly important to ensuring that calves suckle and hence receive colostrum quickly after birth. Calves should be attempting to stand within a few minutes of birth. However, some studies have shown that up to one in four calves do not suckle by six hours after birth. Risk factors for poor vigour such as management, genetics, nutrition and prolonged calvings should be addressed at herd level. Any calves with delayed suckling should be assisted.

That said, opportunities for human intervention differ in extensive beef suckler systems compared to beef calves born to dairy dams. In suckler herds, the calf may not be observed until a while after calving, so suckling is often assumed rather than noted.

There are signs to look out for that indicate successful suckling:

- Abdominal distension in the calf
- Calf active and alert
- Dam's udder empty

Three-point plan

1. Quantity – provide sufficient colostrum to the calf

Dairy-bred calves should have three litres of colostrum as soon as possible after birth and ideally within two hours. If the calf is suckling, this intake usually requires 20 minutes of the calf suckling on its dam. The aim should be to repeat this level of colostrum feeding within six to 12 hours. The more colostrum a calf drinks as soon as possible after birth and within its first 24 hours of life, the better its protection against disease will be.

In situations where suckler calves are too weak to suckle or cannot suckle due to the dam or other reasons, they should be hand-fed three litres of colostrum by stomach tube, nipple bucket or bottle as soon as is safely possible after birth, followed by a second, similar feed within six to 12 hours.

Intervention in extensive systems is often impractical. However, if it is possible to supplement poor-looking animals, calf weight and colostrum quantity should be measured accurately to make sure enough is given. Where safe handling of suckled calves is not possible, careful observation is essential to ensure good mothering is taking place. This is particularly important for heifers and after difficult calvings, where the dam may be reluctant to let the calf suckle. Calves that experience a difficult birth need extra colostrum.

2. Quickly – every minute counts

The efficiency of antibody absorption from colostrum declines rapidly during the first few hours of life. It is very important that calves receive their first colostrum feed as soon as possible after birth, ideally within two hours, to maximise the immunity it can provide. The Welfare of Farmed Animals (England) Regulations 2000 require every calf receives bovine colostrum within the first six hours of life.



Passive immunity is passed from mother to calf through her colostrum

3. Quality is key – colostrum quality varies widely

Cows in poor body condition are likely to produce poor-quality colostrum, while heifers generally produce lower-quality colostrum than cows. Ensuring cows are in appropriate body condition prior to calving and fed an appropriate amount of protein, in the month before calving, can improve colostrum quality.

For orphan calves or those requiring additional supplementation, use good-quality colostrum from cows in second or later lactation, with a known Johne's disease status. The quality of supplemental colostrum can be estimated using a colostrometer or Brix refractometer. Measurements using a colostrometer are affected by temperature and require a large volume of colostrum (250–300ml). For this reason, the Brix refractometer is becoming more popular as only a few drops of colostrum are required and the measurements are less affected by temperature and freeze-thawing. Colostrum with a Brix reading of 22 per cent or less should be discarded.

Hygiene is very important when giving supplementary colostrum. Use clean equipment and do not use mastitic or dirty milk, as high bacterial loads may significantly reduce absorption of colostrum through the gut. Similarly, do not feed colostrum or milk containing antibiotics.

Bacteria proliferate rapidly in warm colostrum, which can be harmful to the calf. Ideally, freeze excess colostrum from individual cows, unless it is to be used immediately. Alternatively, colostrum that has been rapidly cooled in iced water or a farm refrigerator to less than 5°C will remain usable for up to 48 hours.

Bought-in colostrum increases the risk of importing diseases such as Johne's disease. Try to source it from low-risk herds with known health status. Commercial colostrum replacers generally contain only a fraction of the antibodies found in cows' colostrum and should therefore only be used as a last resort.

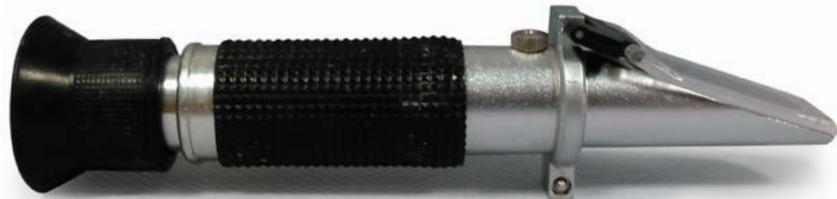


Figure 1. A colostrometer or Brix refractometer can be used to measure supplemental colostrum quality

Providing adequate nutrition

The immune system of malnourished animals is weak. Calves' defences can be improved by supplying the correct nutrition to meet their requirements at every stage of development.

The impact of the weather also needs to be considered. In cold, wet, windy conditions, energy requirements are higher and therefore energy intake of youngstock needs to increase.

Good nutrition will help a calf combat disease.

The opportunity to give additional feed to poor-performing calves in beef suckler systems is more challenging than for intensively reared calves. However, creep feed may be offered to growing beef calves.

Monitoring adult beef cow body condition can give an early warning that grazing or forage is inadequate for milk production, as can monitoring sward heights. In these cases, supplementation with feed or early weaning can be considered.

Creep-feeding suckling calves is also a good way of reducing calf stress at weaning and getting them used to the housed ration. A creep feeding station offered to autumn-born calves in their first winter enables them to feed in safety away from the cows. Scouring in calves is often reduced by doing this, as the creep area can be kept clean and relatively free from contamination.

The performance of calves will be lower the more stress put on them.



Avoid disbudding at key times such as weaning to keep stress levels down

Management of stress

The negative effects of stress are cumulative, so the more stressors there are in a calf's life, the lower its performance will be.

The highest risk period is usually at weaning, but risk is farm-specific. Stress may result from some or all of the following:

Exposure

- Mixing different groups of cattle, especially of different ages or from different sources
- Housing after grazing pasture, assembling in yards, congregating around feed troughs, etc
- Disease transmission from other animals

Physiological stress

- Castration
- Disbudding
- Loss of contact with dam

Environmental stress

- Insufficient feeding space or water provision
- Transport and handling
- Change of environment
- Change of diet, unfamiliar feeds

Calves can fight disease better when they are not stressed, so avoid disbudding and castration at weaning. These procedures should be performed when calves are young, while they still have circulating immunity from the colostrum they consumed. Disbudding very young calves also avoids the more stressful procedure of dehorning later on.

Keep herd groups stable, handle calves quietly and maintain a regular routine.

Reducing stress at weaning

Suckled beef calves

- Introduce concentrates to spring-born calves at grass at least one month prior to weaning and feed the same concentrates after weaning
- Provide a clean creep area where autumn-born calves can lie and access creep feed
- Do not house and wean calves on the same day, minimise the number of stressors that calves are exposed to at any one time
- If you have no option but to house calves at weaning, keep stocking rates as low as possible, provide lots of clean bedding and ensure the shed is well ventilated
- Wean calves in good weather and remove the cows from the calves. The removed cows should be moved out of sight and sound of the calves
- Consider initial housing at night only
- Vaccinate all calves for pneumonia, giving both doses two weeks before weaning
- Check need for gut worm, lungworm and liver fluke control
- Wait at least two weeks after weaning before selling calves

Dairy-bred calves

- Ensure calves are eating at least 1.0kg/head/day of early weaning compound for three consecutive days before weaning
- Ensure easy access to clean drinking water
- Retain in same building, ideally for at least two weeks after weaning
- Make diet changes slowly, introducing new feeds gradually, over a period of two to three weeks

Plan a strategy with your vet that will reduce stress at weaning.

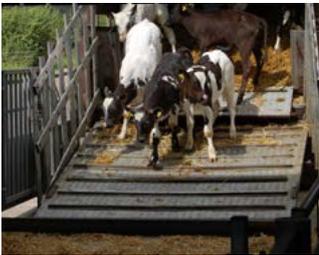
Mitigating risks prior to arrival

Bringing in disease is a major threat for farms purchasing cattle of unknown health status.

Developing long-term relationships with suppliers will help to ensure that pneumonia risk factors prior to arrival on the unit are effectively managed. Depending on the way calves are sourced, try to ensure that:

- Colostrum management practices on farms supplying dairy-bred calves are excellent
- Calves are sourced from herds that are certified free from BVD
- Transport stress is minimised by using good-quality hauliers and keeping travel times down
- Calves are transported directly from the farm of origin and not mixed at collection centres and markets
- Transportation does not coincide with other stressful events, such as weaning, castration, disbudding, etc
- The number of source farms are kept to a minimum
- Calves are vaccinated against key respiratory pathogens at least two weeks before transport (this is not possible for very young calves)

Discussing a sourcing policy with a vet will help to address these and other risk factors.



Allow incoming cattle to settle in a clean pen with access to water to help them recover from the stress of travelling

Mitigating risks on arrival

When calves arrive, the objective is to settle them as quickly as possible as they are particularly susceptible to pneumonia if stressed. To reduce stress:

- Prepare penning and handling facilities in good time
- Provide immediate unloading into a clean, separate area with clean water
- Try to group calves according to their herd of origin
- Minimise the age range of calves within the same building and fill the building as quickly as possible
- Leave the group to settle quietly
- Provide feed in clean feeders. As diet change is a significant source of stress, try to match the diet with what they were fed before as closely as possible
- Take extra care with dairy-bred calves still on milk replacer or extensively reared suckler calves that have not experienced supplementary feeding before

Strict biosecurity is required to manage the risks of purchased cattle.

Mitigating risks after arrival

Once calves have settled and been provided with feed and water, apply a health management plan agreed with a vet. This may include:

- Routine checking of weight and condition
- Treatment for worms and liver fluke
- Vaccination against key respiratory pathogens
- BVD testing and removal of 'persistently infected' calves if not sourced from BVD-free herds
- Control of coccidiosis and other infections that will leave calves at increased risk of BRD

Bovine viral diarrhoea (BVD)

BVD is not a respiratory pathogen in itself. However, it damages the calves' immune system, leaving them prone to BRD. The impact on cattle health is so severe that there are now eradication programmes throughout the UK.

For more information see: bvdfree.org.uk

Treatment options

There are no anti-viral treatments available for use in cattle, so treatment is with antibiotics for secondary bacterial infections and non-steroidal anti-inflammatory drugs (NSAIDs).

NSAIDs reduce fever and relieve pain and importantly, help lessen damage to the lungs. Antibiotics have a role in treating both secondary infection and primary bacterial pathogens such as *Histophilus somni*.

Careful choice of antibiotics is essential and cost per dose must be balanced against the duration of protection provided.

Successful treatment should result in rapid clinical improvement to minimise lung damage and also avoid relapses. Keeping good records will enable the effectiveness of treatment regimes to be assessed.

In-contact calves may also benefit from treatment due to subclinical disease. Discuss this with your vet before undertaking any BRD treatment programme, as the vet may decide to undertake diagnostic tests (see page 3) to select the most effective treatment. These tests are always best conducted at the start of an outbreak and on animals that have not yet been treated. Some antibiotics may not be effective against the bacteria involved in the outbreak, while vaccination during an outbreak may be appropriate for some diseases (eg IBR).

Affected calves will require additional nursing. They should be clearly identifiable (spray marker) and monitored closely to ensure that treatment has been effective. They may require additional support, such as rehydration with electrolytes if they become dehydrated. Isolation of affected calves, despite theoretically helping to reduce the spread of infection, is rarely practical where more than one animal is affected and is in itself stressful. There is an argument for isolating chronic cases, due to the risk they pose to the other animals in the group.

Vaccination

Vaccination protocols are an essential part of herd health planning and should be developed by the farmer and vet together. The exact programme will differ for each situation, but will need to address the following question – what do I want to protect against?

Vaccination against the four key viruses can dramatically reduce calf pneumonia outbreaks.

This will depend on the disease and biosecurity status of the holding and how long animals are kept on the farm. In closed herds, vaccines targeting specific viruses or bacteria may be selected on the basis of diagnostic tests on the farm (see page 3). In open herds, the unpredictable nature of incoming infections requires the use of vaccines which provide protection against a broad range of infections.

Infection frequently starts with primary agents, often viruses. Once these have caused initial damage, bacteria can enter as secondary invaders, causing further damage to the lungs. Vaccination reduces both the severity of disease in the vaccinated animal and the amount of pathogen that is 'shed', thereby reducing the infection pressure on surrounding animals. In some cases, vaccination against four key viruses can dramatically reduce calf pneumonia outbreaks.

Currently available vaccines protect against lungworm, IBR, BVD, RSV, PI3, *Mannheimia haemolytica* and *Histophilus somni*. Unfortunately, there are no vaccines available for other bacteria such as *Pasteurella multocida* or *Mycoplasma bovis*. This means that vaccination should always be used in conjunction with efforts to reduce BRD risk factors.

When handling vaccines, it is vital to follow the manufacturer's instructions. Poor storage, wrong dose rate or timing reduce their effectiveness significantly.



Vaccination is an essential part of health planning

Tips for vaccination

Vaccines sold in the UK are proven in terms of efficacy and safety. They are excellent tools for the prevention of infectious disease. Despite this, money spent on vaccines can be wasted if the manufacturer's instructions are not followed precisely because they will not provide full protection.

Store and handle correctly

Vaccines are particularly vulnerable to temperature damage. There is little margin for error so vaccines must be kept in reliable fridges and kept cool during transit. They must not be used after their expiry date.

Use at the right time

Where a course of vaccination is necessary, this must be completed for it to be effective. Where a booster is required after a year, delaying beyond this time period will result in vaccine failure.

Timing relative to disease challenge is also important, with vaccine immunity starting as soon as four days after administration for some intra-nasal vaccines and up to three weeks after a second dosage for some injectable vaccines. It is therefore essential that calves are vaccinated so that immunity starts prior to the period of risk.

Inject correctly

Always follow the product data sheet and avoid injecting in the rump. Injecting with dirty equipment may interfere with the effectiveness of vaccines.

Consider the health status of the calf

For a vaccine to be effective, it needs to be used under normal environmental conditions. Effectiveness will be reduced if the animal is run-down or under stress, particularly if housed in a poor-quality environment. Always seek veterinary advice before combining vaccines or treatments.

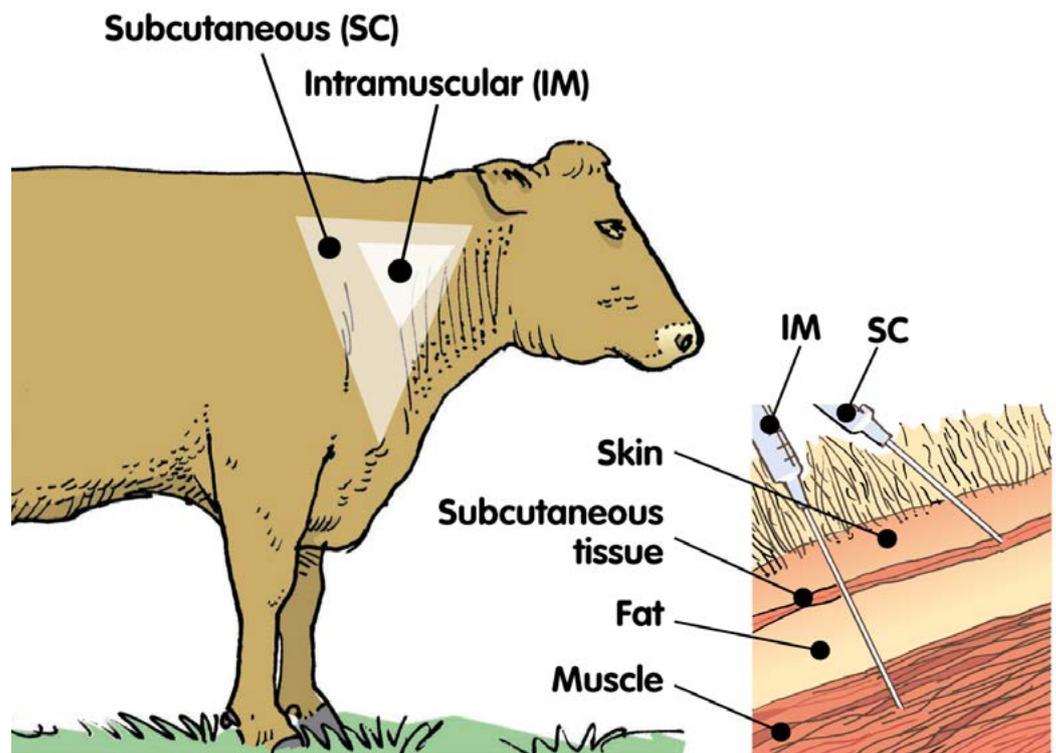


Figure 2. Injection sites and needle position

Environment

The environment has a large impact on the animal and the pathogen load.

Role of the environment in BRD

The environment in which animals live has a large part to play in optimising health and performance. There are two routes of influence:

- Impact on the animal
- Impact on the pathogens that cause disease

For example, damp conditions can favour some pathogens as well as affecting animal behaviour and forage quality, which all contribute to the risk of BRD.

Comfort zone

The lower critical temperature (LCT) of an animal is the temperature below which it has to divert energy towards keeping warm. At this point, less of the feed consumed is available for growth than it would be at temperatures above the LCT. The immediate impact is that daily liveweight gain is reduced.

The relevance for BRD is that prolonged exposure to ambient temperatures below LCT becomes a physiological stress, at which point immune competence is compromised, hence the animal is more likely to succumb to disease.

If respiratory pathogens are present in a group of animals where one or more are below their LCT, there will be an increased risk of BRD.

Table 1 shows that as cattle grow and become heavier, their LCT reduces, enabling them to withstand lower temperatures without becoming stressed. Similarly, as growth rates increase, LCTs tend to reduce.

Table 1. Lower Critical Temperature (LCT) in °C of continental-bred steers (wind speed 0.5m/s)

Diet quality	Growth rate	Liveweight (kg)		
		100	300	500
MJ/kg DM	(kg/d)			
9.4	0.50	4.7	-2.5	-7.5
11.3	1.00	-0.8	-7.4	-12.8
13.2	1.25	0.2	-6.1	-11.2

Key environmental variables

The key environmental variables that can influence the prevalence and severity of BRD are:

- Moisture levels
- Air quality
- Air speed

Moisture levels, air quality and air speed in a building can significantly affect the prevalence and severity of BRD.

Temperature can have an influence when particularly low or high, but is not a consistent factor.

Floor design, bedding and ventilation contribute to how the three key variables above may be managed.

Table 2. Possible effects of three key environmental factors

Factor	Contribution	Signs to look out for*
Too much moisture	<ul style="list-style-type: none"> • Supports microbial activity • Promotes bacterial growth (some species) • Absorbs energy • Acts as a transport medium for pathogens • Increases slippery floors, causing stress • Increases LCT 	<ul style="list-style-type: none"> • Pooled dirty water • Dirty cattle • Damp floors in areas that could be dry • Water ingress • Leaking drinkers • Condensation • Staining on underside of roof • Animal health problems
Lack of fresh air	<ul style="list-style-type: none"> • Increases survival time of airborne pathogens • Increases concentration of gaseous emissions • Can reduce oxygen concentrations 	<ul style="list-style-type: none"> • Smell of ammonia, dampness • Dark corners – no light, no ventilation • Elevated air temperatures • Animal health problems
Air speed	<ul style="list-style-type: none"> • Too much is associated with excessive energy losses • Increases LCT 	<ul style="list-style-type: none"> • Animals avoiding certain areas • Animal health problems • Huddling • Hairy coat • High intake/low productivity
	<ul style="list-style-type: none"> • Too little is associated with lack of fresh air 	<ul style="list-style-type: none"> • Animal health problems • Animals avoiding certain areas • Lingering smell

*Consider the whole housing season, not just the current situation

Moisture

Moisture is ever-present in animal housing. Many respiratory and intestinal pathogens thrive in moist environments and generally find it hard to survive in dry conditions. A primary aim of healthy animal production is to prevent the accumulation of excess moisture. Think about the design options below for improved moisture management.

Table 3. Design consideration for new and existing buildings to allow improved moisture management and control

Factor	Consideration
Competent drainage	1 in 20 slopes under straw, channels in floors to intercept excess liquids
Competent ventilation	Heat and moisture are continually produced and must be constantly removed, along with circulating bacteria, viruses and gases
Dry bedding	To maintain thermal comfort and absorb excess moisture at animal level
Sympathetic building materials	Cold surfaces promote condensation, keeping moisture in the building. Tin may be low-cost but can be an expensive material in youngstock systems due to poor thermal properties
No additional moisture	Moisture can be prevented from entering a cattle building by paying attention to downpipes and gutters, good building maintenance and keeping groundwater away by sensible drainage

Another problem for UK farmers is that damp environments are invariably cold. Damp conditions increase the rate of heat loss from a warm body, with negative effects on health and performance, particularly for youngstock.

The impact on a calf's body temperature of lying on a damp bed is shown in Table 4. Lying on wet straw diverts a small calf's energy from growth to maintaining body temperature.

Table 4. Lower critical temperature (LCT) for a calf lying on different surfaces (well fed and in calm air)

Relationship with floor	Lower critical temperature (°C) for a 50kg calf
Calf lying on dry concrete	17
Calf lying on dry straw	8
Calf lying on wet straw	>10

When bedding is damp, youngstock spend more time standing up than lying down which results in reduced liveweight gain and feed conversion efficiency.

Prolonged periods of exposure to damp conditions can also lead to calves becoming more prone to BRD and other infections.

Damp bedding can reduce performance and increase exposure to infection.

Deep, dry straw has good insulating properties, which makes it a good bedding material for young calves.



Deep, dry straw offering thermal comfort to a calf



Thermal properties of timber walls are superior to concrete for youngstock, although can benefit from lining with a non-porous surface to aid effective cleaning

Fresh air/air quality

Ensuring fresh air for animals to breathe is vital for successful animal production. It not only promotes respiratory health, but also maximises growth rates and feed conversion efficiency.

Aerial transmission is an important route of infection for BRD. The bacterial and viral pathogens involved have to survive moving through the air in substantial numbers to infect new hosts.

One hundred per cent clean, fresh air can kill airborne bacteria and viruses 10–20 times more quickly than 50 per cent fresh air.

Providing adequate ventilation is essential for keeping housed calves healthy. For more information on ventilation, see page 15.

Wind chill/air speed

Increased air speed at animal height:

- Increases the risk of immune suppression
- Severely increases the negative impact of low temperatures on youngstock

The air temperature at which young calves are physiologically comfortable is seldom applied as a design consideration in UK housing systems.

Table 5 shows that under typical UK winter conditions, air temperature will be below the LCT of young calves. Furthermore, the LCT increases when an animal is exposed to draughts.

Table 5. Effect of air speed and calf weight on the LCT of a standing calf

Calf weight	Lower critical temperature (LCT)°C at two different air speeds	
	0.2m/s	2.0m/s
35kg	+9	+17
50kg	0	+9
100kg	-14	-1

Increasing air speed at animal height increases LCT.

The longer an animal is exposed to environmental conditions below the LCT, the greater the risk that the animal's immune system will be suppressed, so increasing the risk of disease.



Take steps to avoid draughts at calf level such as using rubber at the bottom of gates and windbreak materials

Table 5 shows that even a small increase in air speed at animal height increases LCT significantly and is more of a thermal stress than lying on a wet bed.

Note that the air speed applied in the research is 2.0m/s, which is only half the average air speed around the UK. Higher air speeds in a draught will increase the negative effect.

Ideally, air speeds should not exceed 0.5m/s, because of the effects on increasing LCT and stress. However, this may not always be possible and a maximum of 2.0m/s may be a more practical, higher air speed limit, particularly for animals above six months old.

Use windbreak material to protect large openings.

Design detail – ventilation

The competence of a ventilation system is a key factor in managing moisture. The absolute requirements of a ventilation system are:

- Removal of foul air containing gases, odours, dusts and airborne bacteria/viruses
- Removal of excess water vapour
- Removal of excess heat (energy)
- Introduction of clean, fresh air
- Provision of the above across the whole area of a building, while preventing the introduction of additional moisture (rain) and excessive air speeds (wind)

These design requirements are not easy to achieve given that most buildings have no moving parts except the doors. Moreover, the weather is changeable and can come from all directions, while the internal conditions, including numbers and weight of animals, constantly change.

However, a few basic rules can be applied to assess whether the ventilation of a building is providing a healthy environment for the animals living inside it:

Buildings need a roof outlet to release warm, moist, foul air.

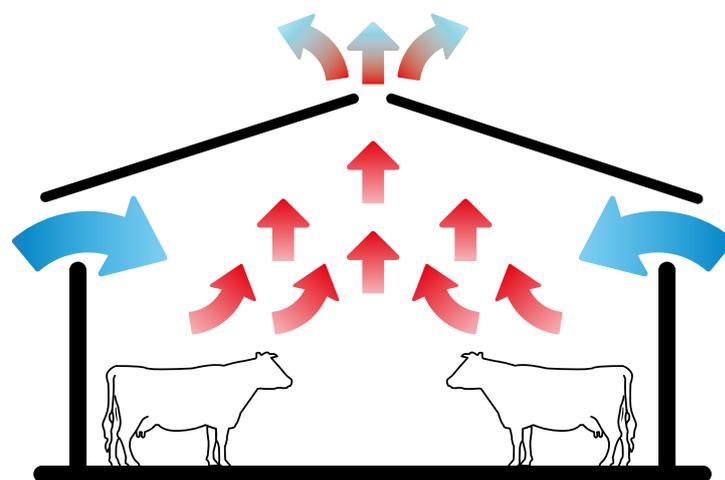
The inlet area needs to be a minimum of twice the outlet area but ideally four times.

- There is an absolute requirement for an outlet in the roof to let warm, moist, foul air escape (rule of thumb: outlet area needs to be 0.04m² per calf and 0.1m² per growing or adult animal)
- Outlets work well at ridge height, but can be spread across the roof area
- Inlet area, ideally spread across both sidewalls, needs to be at least twice the outlet area and ideally four times the outlet area
- Inlet area must be able to control air speed, ie reduce wind speed
- Gap size in spaceboard should never exceed 25mm (1in)
- Air speed must be controlled at animal height

The stack effect

Most UK cattle buildings have natural ventilation, meaning they are ventilated by wind energy most of the time. But when wind speeds drop, it is essential for a building to be able to ventilate itself by the 'stack effect' (Figure 3).

This occurs when an accumulation of warmer air from the body heat of the animals is able to rise and leave a building, drawing clean and fresh air into the building through the side inlets.



The Stack Effect

Figure 3. The stack effect inside a naturally ventilated building

To allow this to happen, it is essential to have an adequate outlet area in the roof. If there is no hole in the roof or the hole is not big enough, then heat, moisture and foul air will accumulate inside the building faster than they can leave. The resulting environment will be perfect for bacterial and viral survival, which is why there is a clear association of BRD incidence with still, damp weather.

The precise detail of ventilation areas in cattle buildings is refined by attention to the slope of the roof, stocking density, liveweights and building materials. However, the rule of thumb expressed above is robust enough for assessing whether the current ventilation within a building is increasing the risk of BRD. A method for calculating the exact area of outlet for any naturally ventilated cattle building is shown in the Appendix A1 (page 25).

Inlet designs

Well-designed inlets have two principal design requirements.

Firstly, they allow adequate fresh air in along both sidewalls of the building so that the exit of stale air through the roof is not restricted.

Secondly, inlets should reduce wind speed at animal height so that draughts and excessive heat loss do not occur.

While large, single inlet areas such as open gates and doors may provide sufficient fresh air to an area within a building, they are not suitable for controlling wind speed across the animals. Note that uncontrolled air speed at animal height is only likely to be beneficial in the UK during the warm, summer months.

Outlet designs

The outlet area is best provided by a narrow opening (Figure 4; width Y) along the length of the ridge, 150–350mm (6–14in) wide, depending on stocking and building design. For accurate requirements, refer to Appendix A1. The wider the opening, the more likely rainwater is to come in. In this case, a covered open ridge (Figure 4) is appropriate. This type of ridge should also be used above cubicles or wherever rainwater entry could be a problem.



Slatted building with restricted air inlets. Opening up the inlet areas is easy and would improve health and performance

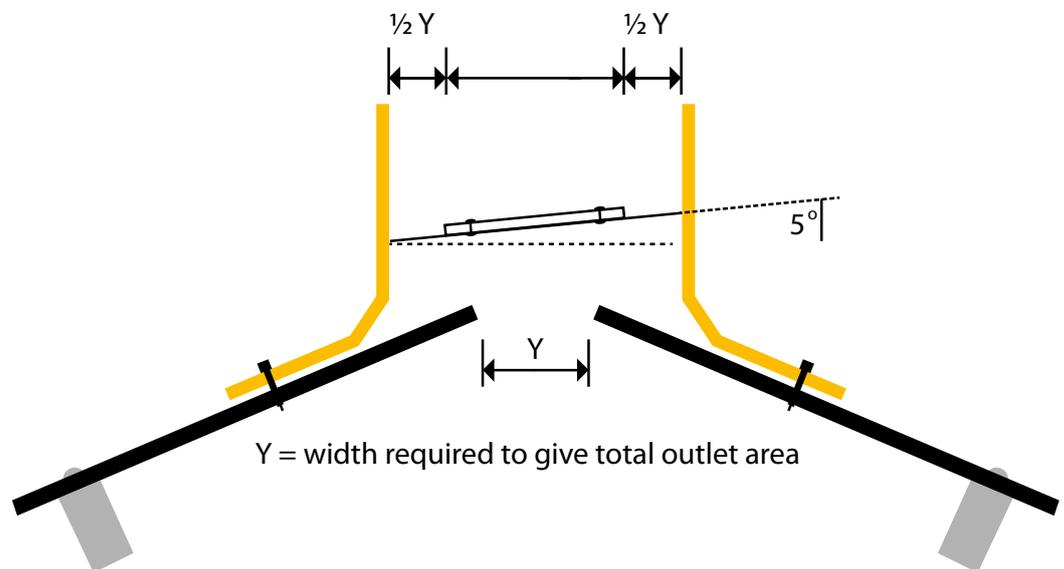


Figure 4. A covered open ridge



A slotted roof can increase outlet area

There are a number of methods to achieve adequate outlet ventilation, including various ridge designs or slotted roofs.

An open ridge (Figure 5) is usually between 200–350mm (8–14in) wide and should be unrestricted.

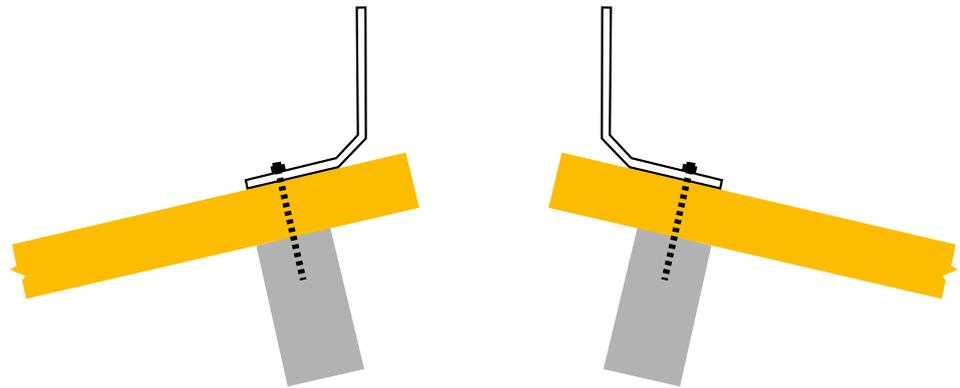
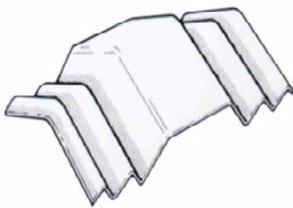


Figure 5. An open ridge

The light ridge is useful as it provides an adequate outlet area and additional natural light within a building. It is particularly useful for improving existing buildings, where the two sets of purlins supporting an existing enclosed ridge are widely spaced (>700mm apart), and fixing a 200–300mm open ridge would normally be difficult.

Slotted roofs, where roof sheets are inverted and fitted with a space of around 10–20mm between each adjacent side sheet, can be very useful, particularly where housing all year, or on lean-to roofs with a low pitch. They are not suitable for youngstock <150kg. However, they do reduce the flexibility of the use of the building for non-livestock purposes.

Cranked ridges are not suitable as they only offer around 20 per cent of the required outlet, even though they are still commonly fitted.



Cranked ridges do not allow enough air to escape and should not be fitted

Floor design

The floor must provide a safe, durable base to the pen and the surrounds that can be cleaned effectively. It should have a non-slip surface but not be abrasive to the animals' feet. In terms of supporting a healthy environment to prevent BRD, the key factor relating to floors is drainage. The target is either:

- To keep all the moisture under the bedded area
- or

- To allow excess moisture to be channelled away from bedding and livestock

Health problems arise when moisture accumulates at floor level or on the bedding surface. Pooled liquid adds moisture to the air in the building, increases bedding costs and creates a colder bedding surface for animals to lie on.

For a young animal, damp bedding may take it below its LCT, bringing the risk of suppressed immunity. Damp bedding and cubicles also provide a supportive environment for the proliferation of bacteria and viruses.

Good flooring design takes into account where excess water might accumulate, eg:

- Around water troughs
- Within 2–3m (6.5–10ft) of an automatic calf feeder
- Along the front of single calf pens



A simple drainage channel removes excess water away from the calves

Floors must be safe, durable and carry liquid away from the animals and their lying areas.



Calves spend more time lying down than standing up so lots of dry, clean bedding is essential

Straw choppers should not be operated in buildings with stock below three months of age.

These areas should be provided with additional slope and channels to specifically gather and remove excess liquid from the animals' environment.

A calf naturally wants to spend more time lying down than standing up. A dry bed is essential to maintain health and minimise stress levels. The aim should be to provide good floor drainage under straw, by:

- Having drainage channels to collect and carry away excess moisture
- or
- Having a porous surface under the straw, such as slats or hardcore
 - Regularly bedding up

Use the best straw on the unit for bedding youngstock. Damp bedding materials reduce thermal comfort, do not absorb urine well and contain large concentrations of mould spores and toxins. Dusty, mouldy materials in bedding are a risk factor for BRD.

Note: straw choppers should not be operated in buildings with stock below three months of age, as the normal clearance mechanisms of the lungs are not fully developed. Straw choppers should also be used with caution where older stock are showing respiratory symptoms.



Automatic calf feeders are a focal point for animal contact and should be kept clean to minimise risk of disease spread

Troughs and feeders

The role of troughs and feeders in the spread of respiratory disease is not well understood. However, it has been shown that the virus causing IBR can survive in them for 30 days.

These essential facilities, which act as focal points of contact between all animals in a group, therefore pose a high risk for pathogen transfer. They should be routinely cleaned to reduce contamination.

Automated calf feeders can also bring about disease spread. While the cleaning systems of the machines are very good, the design and cleanliness of their immediate environment must not be overlooked.

Hygiene

There should be zero tolerance to poor hygiene for youngstock. Cleaning is essential, requiring the appropriate materials and the right amount of time to do the job.

The most important part of a good hygiene policy, especially in modern production systems, is time – not only to carry out the work, but also to allow floors, pens, fittings and utensils to dry after cleaning.

Allowing a drying period helps kill bacteria and viruses that survive the active cleaning process and is a vital part of biosecurity.

During routine cleaning of feeding equipment, avoid adding moisture to the building during washing. Water troughs and buckets should be emptied directly down drains or outside the building and should not be poured out onto the bedding or concrete. Ideally, the wash-up area should be in a separate air space from the calves so that drying buckets and utensils do not add to the humidity in the animals' environment.

There should be zero tolerance to poor hygiene for youngstock.

Pathogens

Main agents

Bovine respiratory disease is a complex problem. It is not caused simply by the introduction of a specific infectious agent into a susceptible group of animals. Indeed, many of the causal agents are often already present in the animals.

Frequently, respiratory infection results from the calf becoming infected with a primary agent first, usually a virus; then the resulting lung damage allows a secondary bacterial infection to develop.

Table 6. The main agents of BRD

Bovine Respiratory Disease – main agents		
Viruses	Bacteria	Mycoplasma
<ul style="list-style-type: none"> • Parainfluenza virus (PI3) • Bovine respiratory syncytial virus (RSV) • Bovine herpes virus (BHV-1) • Bovine Viral Diarrhoea (BVD) 	<ul style="list-style-type: none"> • <i>Histophilus somni</i> (<i>H. somni</i>) • <i>Mannheimia haemolytica</i> (<i>M. haemolytica</i>) • <i>Pasteurella multocida</i> 	<ul style="list-style-type: none"> • <i>Mycoplasma bovis</i> (<i>M. bovis</i>) • <i>Mycoplasma dispar</i>

The table below outlines the common disease syndromes. Disease patterns exhibited are often different in suckled beef calves compared with dairy calves.

Table 7. Common respiratory disease presentations and likely disease agents

Management group	Clinical syndrome	Likely pathogens
Housed dairy-born calves less than six months old and housed suckled calves born indoors and housed from birth	Severe acute pneumonia	RSV, P13, <i>M. bovis</i> , <i>H. somni</i> , <i>M. haemolytica</i>
	Chronic coughing	<i>Mycoplasma</i> spp.
Suckled calves at foot housed after summer	Severe acute pneumonia	<i>M. haemolytica</i> , RSV, P13, <i>H. somni</i>
Housed, weaned suckled calves	Acute upper respiratory tract disease	IBR
Housed, weaned dairy-bred calves after summer	Severe acute pneumonia	RSV, P13, IBR, <i>M. bovis</i> , lungworm

Although the above pathogens are potentially well controlled with effective vaccination, other pathogens for which there is currently no effective vaccine available are emerging with increased significance.

Lungworm (*Dictyocaulus viviparus*) may be responsible for severe outbreaks of BRD in animals that were exposed to high levels of worm challenge at pasture. Proactive control is available through the use of a pre-turnout oral vaccine, or through strategic use of wormers as part of herd health planning.

The bacterial causes of BRD include *Mannheimia haemolytica*, *Pasteurella multocida*, *Histophilus somni* and *Mycoplasma* spp. This last group are bacterial pathogens that can play a role in a number of cattle diseases such as BRD, arthritis and mastitis, but are often underestimated and less well monitored than other causes.

Mycoplasma spp. are widespread and can be present in the respiratory tracts of cattle showing no signs of BRD, with implications for those purchasing cattle. Transmission of disease is via nasal shedding and spread on contaminated objects such as clothing and equipment. However, the bacteria cannot survive for long outside the host, so spread is more likely where direct, close and repeated contact with other animals occurs.

Mycoplasma spp. are widespread and often involved in causing BRD. There is no effective vaccine and success of treatment is threatened by increasing antimicrobial resistance.

Infection can cause mild disease in uncomplicated cases or acute respiratory signs in more severe infections. Infected cattle can also shed and act as reservoirs for the bacteria, while often appearing clinically healthy. These animals are often associated with chronic infection and relapse due to unresolved lung lesions.

There are currently no vaccines licensed for use against *Mycoplasma* spp. in the UK and treatment is continually threatened by antimicrobial resistance. Early recognition and prolonged therapy is therefore necessary, keeping a close eye on the possible development of antimicrobial resistance. Screening purchased stock to prevent buying this disease into the herd is essential, together with good management of cattle and their environment.

Prompt therapy may help reduce the impact of all these pathogens, but long-term effects on production are highly significant. A better understanding of biosecurity and how to support the animals' immune defences is vital to minimising the impact of BRD.

Post-outbreak actions and repeat cases

Following an outbreak of respiratory disease, two principal objectives are to:

- Resolve the consequences of the outbreak on the affected animals
- Investigate the cause/s to inform future management decisions

Although many animals may apparently recover completely, feed conversion efficiency may be affected, which reduces daily liveweight gain. Furthermore, some affected animals may suffer a relapse of clinical signs and require repeated treatments.

Chronic cases become uneconomic and represent a risk to unaffected animals. They should be isolated in hospital facilities and culled if they respond poorly to treatment. Investigating outbreaks should be carried out in partnership with the farm vet. The aim is to prevent respiratory disease and to assess if specific measures, such as targeted vaccination programmes or building improvements, may be appropriate.

Pneumonia MOT

Respiratory disease of cattle (more commonly known as pneumonia), is one of the most significant diseases affecting English beef production. Cattle succumb when the disease pressure overcomes their immune system, which could be caused by a range of management factors. This checklist provides guidance on identifying problem areas.

A separate checklist is available for calf rearing systems at beefandlamb.ahdb.org.uk

Animal	
Action	Interpretation
Weight for age	
Source cattle that have grown well during early life	Cattle with poor weight for age are likely to be high risk and should be avoided where possible Good nutrition and vaccination will help to boost their immune system
Health status of farm of origin and colostrum	
Source cattle from herds with a known health status. Ensure the farm of origin is BVDFree and that they received sufficient colostrum as calves	Calves that have not had adequate colostrum will have sub-optimal performance and be more susceptible to health problems. Calves that are persistently infected with BVD represent a significant respiratory disease risk to the rest of the herd
Growth rate	
Weigh calves regularly to assess growth rate	Growth rates lower than 0.7kg/day indicate sub-optimal nutrition or health
Body condition score (BCS)	
Manage dry cows and heifers to ensure correct body condition at calving and throughout the year	At calving, aim for spring calvers to have a BCS of 2.5–3.0 and autumn calvers to have a BCS of 3.0 Ideally, the cows should be in the correct BCS six weeks before calving
Trace element profiling	
Ask your vet to assess levels of copper, cobalt, selenium and vitamin E in suitable batches of youngstock	Deficiencies or excessive levels of trace elements can be responsible for impaired immune status

Environment/housing

Action	Interpretation
Bedding	
Bedding should be plentiful, clean and dry	Ensure there is sufficient clean and dry bedding available. There should not be a noticeable squelch when the welly boot is lifted up
Design and dimensions	
Ensure adequate air inlet and outlet areas	The ideal outlet area depends on the stocking density (kg LW/m ²), the average animal weight (kg) and the difference in heights between the inlets and the outlets To calculate ideal outlet and inlet areas, see Page 25: A1: Ventilation calculations
Ensure there are no water leaks	Avoid water leaks from gutters and water troughs
Ventilation	
Ignite at least two smoke emitter pellets at different points within an occupied building on a still day	Observe smoke to identify good and poor areas of ventilation within a building
Measure smoke clearance times and observe smoke clearance patterns	Smoke should ideally travel up and out of outlet areas
Assess atmosphere for 'stiffness' and a lack of fresh air	Slow movement throughout the building indicates a high risk for transfer of pathogens from one affected animal to an entire group due to poor air flow The rate of clearance crudely indicates how frequently air is being changed within a building. Smoke should clear in 30–45 seconds
Observe general cleanliness of the building, eg cobwebs, dust, etc	A build-up of dust or obvious cobwebs are clear signs that ventilation is inadequate, with insufficient air changes occurring
Humidity	
Assess humidity using a humidity meter if available, or visual signs such as rusting and stained roof structures	Relative humidity should be less than 75% to reduce survival of exhaled pathogens and spread between animals Dark stains on purlins or roof sheets and corrosion on steelwork indicate excess humidity
Draughts	
Measure air speed at calf level at multiple points in the shed if possible and use smoke pellets to observe smoke patterns	Take action to avoid draughts at calf level Air speeds over 2m/s will impact the growth rates during cold weather of youngstock weighing less than 300kg
Observe bedding	For youngstock weighing less than 100kg, wind speeds over 1m/s need to be controlled Air should not be able to move bedding

Environment/housing

Action	Interpretation
Stocking rates	
<p>Measure area of building (length x width)</p> <p>Record number of animals in each weight range, then calculate m²/head</p>	<p>Eg 325m² shed area containing 50 x 400kg cattle = 6.5m² per head</p> <p>For minimum recommended space allowances, see page 28: Table A2a</p> <p>If feed is not available ad-lib, check that cattle can all feed at the same time</p>
Transition management	
<p>Take care to minimise stress of cattle moving onto the farm, being weaned or changing rations</p>	<p>Let cattle rest on arrival</p> <p>Try and feed cattle a similar ration to the one they are used to and introduce any new feeds gradually, over 2–3 weeks</p> <p>Avoid making too many changes at the same time, eg do not wean and house on the same day</p>
Transport	
<p>Minimise transport distances and avoid multiple pickup/drop-offs where possible</p>	<p>Transport is a major stressor and minimising the time spent in transit will reduce respiratory disease risk. Avoiding multiple pickup/drop-offs will not only reduce transit time, but also reduce mixing of cattle of different health statuses</p>

Pathogen	
Action	Interpretation
Herd health planning	
Review your herd health plan each year with your vet, based on good health and performance records	<p>A herd health plan is a continuous process to improve animal health and welfare</p> <p>Minimising concurrent health issues will mean cattle are better able to fight BRD infection</p>
Review vaccination plans with your vet	Vaccination is a valuable preventative strategy for controlling BRD. It not only helps protect the animal against BRD, but also reduces the challenge to other cattle in the group
Testing for disease	
Ask your vet to take samples to find out which pathogens are causing disease	These results will help determine the best course of treatment and future prevention strategies
Ensure there are no BVD persistently infected (PI) animals in the herd	<p>PI cattle have a high likelihood of dying in their first year of life</p> <p>Their liveweights are lower than healthy counterparts and incidence of pneumonia can increase by 43% in healthy cattle sharing air space with a PI animal</p>
Faecal sampling	
Test faeces for liver fluke, enteric worms, coccidiosis and lungworm, as appropriate	<p>Faecal sampling can indicate the presence of parasites and indicate how large the burden may be</p> <p>Some pathogens such as lungworm may have a direct effect on respiratory health. Others such as coccidia and liver fluke compromise immune function</p>
Mixing cattle	
Avoid mixing cattle from different source farms and age groups as much as possible	Mixing cattle increases stress and exposure to disease
Shared air space	
Avoid calves sharing the same air space as older cattle	Older cattle can transfer disease to younger cattle even if they are not showing signs of poor health

Pneumonia MOT reference tables

A1: Ventilation calculations

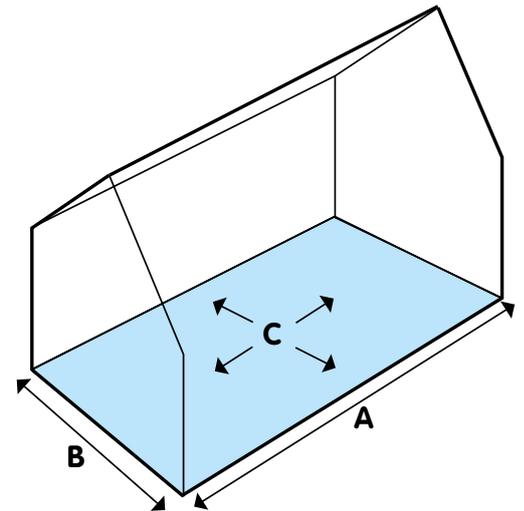
The calculations below estimate the area of outlet and inlet required in a building to ventilate naturally by stack effect.

Insert your own figures in the tables below.

Step 1.

The calculations are shown for the example building:

Building length = 22.86m [A]	
Building width = 18.29m [B]	
Floor area = A x B = 418m ² [C]	
Stocking density = 46 cattle [D], at average 400kg liveweight (LW)	



Where a range of animal weight occurs, use an average weight. Where there are suckler cows and calves, again use an average weight but consider calves at their heaviest weight. Similarly for growing animals use the expected maximum liveweight that the building will be required to house.

Ventilation calculation key

[A] = Building length

[B] = Building width

[C] = Floor area of the building

[D] = Number of animals

[E] = Floor area each animal has

[F] = Outlet area in the roof per animal

[G] = Eaves to ridge height difference

[H] = Building height factor

[I] = Outlet area required

Floor area per animal =
418m² [C] ÷ 46 [D] = 9m² per animal [E]

Step 2.

Outlet area per animal – (use Figure A1a on page 27 to calculate)

Read along the horizontal axis of the graph in Figure A1a to the floor area/animal [E] and find the line for the relevant weight of animal. Read across to the vertical axis.

For example, a floor area of 9m²/animal at 400kg average liveweight requires an outlet area in the roof per animal of 0.12m² [F]

Step 3.

Eaves to ridge height difference (use A1b on page 27 or use own measurements)

The outlet area in the roof per animal [F] needs to be modified by the influence of the pitch of the roof, which is in effect the difference in height between the eaves height and the ridge height.

To calculate the height difference between the eaves and the ridge of a building, either make own measurements, extract the measurement from building plans, or estimate by counting reference points in the gable ends, such as rows of blocks. An alternative is to estimate the slope of the roof and use the multiplier for roof slope below.

Roof slope	Multiplier
10 degrees	0.176
12 degrees	0.213
15 degrees	0.268
17 degrees	0.306
20 degrees	0.364
22 degrees	0.404

Height difference [G] = roof slope multiplier x half the building width [B]

With a 17° pitch the eaves to ridge height difference of the example building is
0.306 x (0.5 x 18.29 [B]) = 2.8m [G]

Step 4.

Outlet area required (use Figure A1b to calculate)

Read along the horizontal axis of the graph in Figure A1b to the height difference of the building. A height difference of 2.8m (the horizontal axis of Figure A1b) corresponds to a height factor (on the vertical axis of Figure A1b) of 0.60 [H]

The actual outlet area required [I] for this example is:

Outlet per animal [F] x height factor [H] x number of animals [D]

Outlet area required is
 $0.12\text{m}^2 \text{ [F]} \times 0.60 \text{ [H]} \times 46 \text{ [D]} = 3.31\text{m}^2 \text{ [I]}$

Step 5.

The outlet area required is a defined value; how this area is achieved in the ridge is flexible. A common solution is to provide a continuous gap along the ridge, in which case the required gap width is the outlet area required [I] divided by the building length [A].

In this case the required ridge gap is
 $3.31\text{m}^2 \text{ [I]} \div 22.86 \text{ [A]} = 145\text{mm}$

The inlet area, ideally split evenly across the two sidewalls is an absolute minimum of twice the outlet area and better at four times the outlet area. In this example, the inlets should be 145–290mm across each side wall. Use the lower figure for youngstock and for exposed sites.

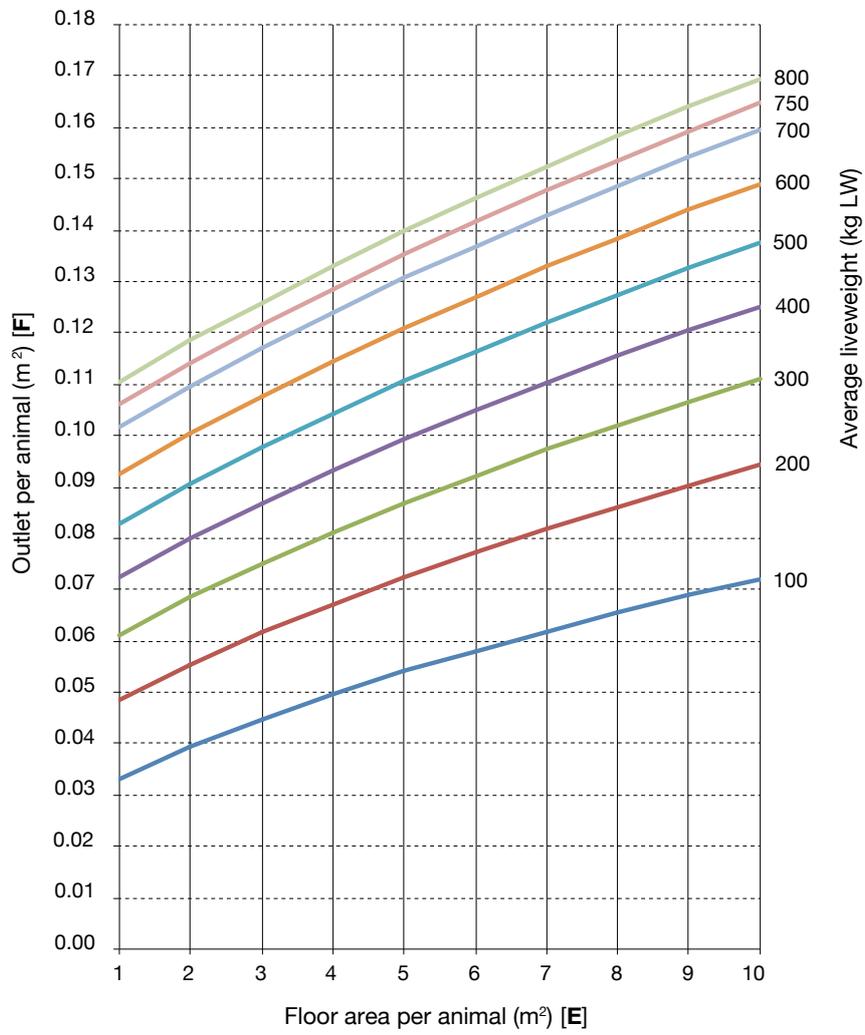


Figure A1a : Outlet area per animal [F]

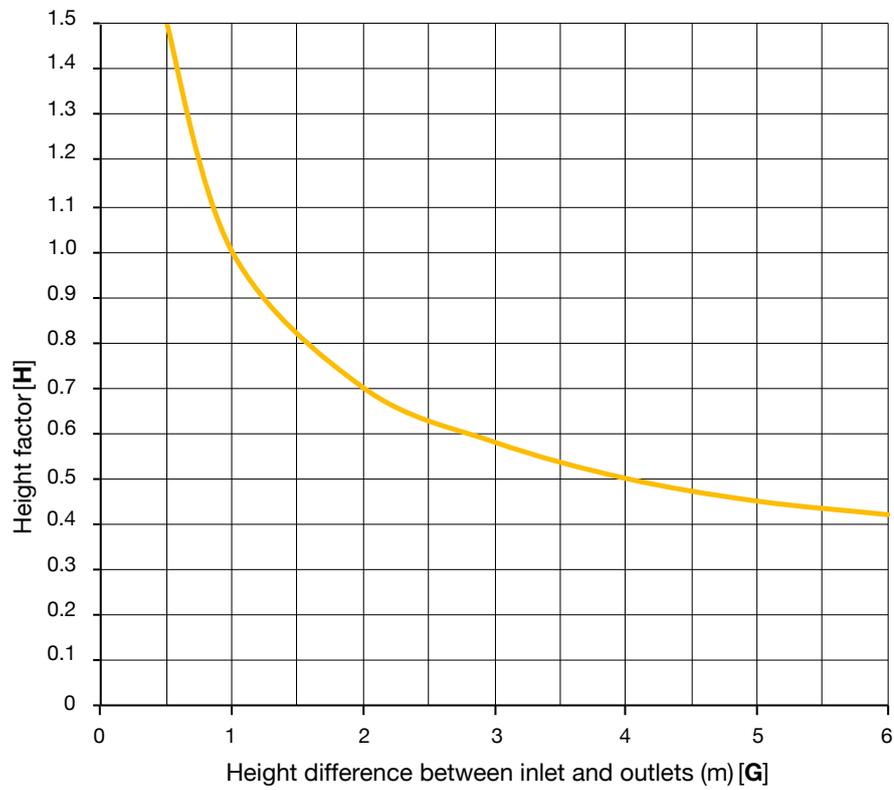


Figure A1b: Building height factor [H]

A2. Minimum housing space allowance guidelines

Always check specific requirements of your cattle buyer and farm assurance scheme as many have minimum space allowances.

Table A2a. Loose housing (based on Red Tractor Standards 2017)

	Liveweight (kg)	Solid floors (m ² /head)		Slatted floors* (m ² /head)
		Bedded area	Total area (incl. feeding and loafing)	
Suckler cows	400	3.50	4.90	n/a [#]
	500	4.25	5.85	n/a [#]
Growing/ finishing cattle and youngstock	200	2.00	3.00	1.1
	300	2.75	3.95	1.5
	400	3.50	4.90	1.8
	500	4.25	5.85	2.1
	600	5.00	6.80	2.3

*Fully slatted concrete floors should not be used for breeding cows or in-calf replacement heifers.

[#]Non-slatted lying areas must be provided.

Table A2b. Minimum cubicle dimensions (based on Red Tractor Standards 2017). Cubicle size must be determined by the size of the animal.

	Liveweight (kg)	Dimensions	
		Length (m)	Width (m)
Suckler cows	<600	2.4	1.15
	>600	2.5	1.2
Growing/ finishing cattle and youngstock	200	1.45	0.7
	300	1.7	0.85
	>350	2.1	1.1
	350	2.05	1.05

Table A2c. Minimum space requirements for calves in group housing (Red Tractor Standards, 2017)

Calf weight (kg)	Space requirements per calf
50–84	1.5m ²
85–140	1.8m ²
140–200	2.4m ²

For more information contact:
Better Returns Programme
AHDB Beef & Lamb
Stoneleigh Park
Warwickshire
CV8 2TL

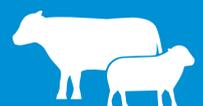
Tel: 024 7647 8834
Email: brp@ahdb.org.uk

beefandlamb.ahdb.org.uk

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