# Care of Confined Cattle

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## Introduction

In temperate zones of the Northern hemisphere, cattle are confined to yards and housing systems. This is primarily for ease of management and for the protection of the land during the wet winter, non-grazing period. Systems of housing and confinement vary considerably and this paper will largely reflect conditions within the United Kingdom, which have been the author's experience for the past 30 years.

When cattle are housed, there are 3 main considerations regarding their care. These are:

- confinement increases cow-to-cow contact, causing greater risk of fecal contamination and traumatic injury to the teats. Excess standing leads to trauma to the feet.
- damp: high water output (50-80 litres per cow/day) produces high humidity within the buildings and this increases the risk of bacterial multiplication and fecal spread.
- welfare may be compromised.

The assessment of welfare and what is right for the cow is extremely difficult. It has been proposed (Webster 1984) that housing systems be assessed according to the degree that animals housed within them are free from 5 considerations:

1. Freedom from hunger and malnutrition
2. Free from thermal and physical discomfort
3. Freedom from injury and disease
4. Freedom from fear and stress
5. Freedom to express normal behaviour.

It is likely that, of all of these, freedom from injury and disease are the most important and these are the 2 issues which will be considered in this paper. The major diseases associated with environmental stress in dairy cattle are lameness, mastitis and fertility. For housed stockyoung, enteric problems and pneumonia are the most important.

## The Interaction of the Environment With Disease

*Lameness*

Sole ulceration, white line disease and digital dermatitis/hairy footwarts are the primary causes of lameness in dairy cattle. An understanding of the pathogenesis of these conditions is necessary to assess how the environment of the cattle can affect them.

*Sole Ulceration*

The axial edge of the lower surface of the pedal bones is arched, so that the weight of the cow is taken on the front and rear parts only, whereas on the abaxial edge, weight is taken along the whole of the lower surface. The small projection of the flexor tuberosity at the axial rear edge of the pedal bone is especially important. If excessive weight is taken at this point, then pinching of the corium occurs between the pedal bone above and the horn of the sole below (Blowey 1993). Pinching leads to release of blood, so that a mixture of blood and horn slowly moves through the thickness of the sole towards the surface during normal growth. This eventually is seen as blood at the sole ulcer site and is often referred to as "bruising". The term is not fully descriptive, because as the sole is 8-10mm thick and the horn of the sole is growing at approximately 5mm per month, surface hemorrhage would have been caused by trauma some 6-8 weeks previously.

A sole ulcer forms when damage to the corium has been so severe that the horn-forming tissue has been totally destroyed. Disruption of the laminar suspension of the pedal bone may lead to it "sinking" onto the underlying corium, thereby predisposing to both sole and toe ulcers and disrupting white line formation (Ossent & Lischer 1994). The pedal bone will now be compressing the corium of the sole, displacing the corium abaxially and into the white line. This leads to widening and weakening of the white line, a hoof which is much wider and poor sole horn production by the corium.

*White Line Abscess*

The white line is a cemented junction between the wall and the sole. It consists of interdigitating cells and horn leaflet cells (Logue, et al. 1990), but lacks any tubular horn and is therefore considerably weaker than the adjacent horn of the wall or sole. The interdigitating horn cells are produced by the corium of the sole. Any process leading to congestion and inflammation of the corium will weaken the cement of the white line and may result in the separation of the wall from the sole.

One of these changes is a loss of the suspension of the pedal bone, referred to above. Following widening and weakening of the white line, stones and small pieces of debris may penetrate. If these reach the corium, abscesses and an under-run sole then develop.

## Mastitis

New intramammary infections arise from mastitis pathogens penetrating the teat canal (Blowey & Edmondson 1995). An understanding of the closure mechanisms of the teat canal will therefore help in the appreciation of the role played by the environment.

The outside of the teat and the inside of the teat canal are lined with keratinized squamous epithelium, a normal skin surface. When closed, the inner lining of the teat canal is folded and the folds interlock with each other to improve the effectiveness of the seal. In addition, a 180mm layer of surface lipid covers the keratinocytes, holding them in place and further improving the teat seal. When milking starts and letdown occurs:

- the teat end unfolds and the canal opens
- milk flows over the lipid, removing milk residue from the previous milking and cleaning the surface of the teat canal
- the surface layer of keratinocytes sloughs away, carrying along any adherent bacteria. This "keratin slough" is extremely important in the prevention of new infections.

The teat must reseal at the end of milking. A peristaltic wave of muscle contraction passes from the teat base to its apex. The teat and teat canal shorten, the contracting sphincter refolds and most of the residual milk is squeezed out. Because of the hydrophobic nature of the lipid surface of the teat canal, any milk remaining in the canal exists in small "lakes" of approximately 3ul. There is, therefore, no solid column of milk, which minimizes the risk of infection tracking up in a "wick" effect. However, if teat closure takes place in a very damp or humid atmosphere, the static column of milk persists for longer and the risk of mastitis is greater.

If the teat end becomes damaged in any way, these delicate closure mechanisms will become compromised and there is a risk that mastitis will result. A cracking of the inner lining of the teat canal could lead to:

- an incomplete lipid seal. Any residual milk could then exist as a solid column and not as small "lakes"
- serum oozing from the cracked canal surface, acting as nutrients for bacteria
- milk flow at the next milking not achieving complete flushing of residual bacteria.

It is therefore vital that cows are housed, managed and fed to optimize these teat-end defenses. Poor housing will increase the challenge of environmental infection at the teat end and may contribute to teat end damage through trauma. Poor management — especially poor milking machine management — will lead to teat end damage, thereby predisposing to mastitis. Poor feeding could result in loose feces and an excessive environmental challenge. A deficiency of dietary sulphur or zinc could lead to poor keratin production and hence a failure of the teat-end defence mechanisms.

*Milk Flow Rates and Susceptibility to Mastitis*

Work by Grindal and Hillerton (1991) demonstrated an interesting relationship between teat end milk flow rates and susceptibility to mastitis. Over the past 30 years, milk flow rates have doubled from approximately 0.8 litres per quarter per minute to the current level of 1.6 litres per quarter per minute. This has led to a 12-fold increase in susceptibility to mastitis. Slow-milking cows do not fit into the milking routine of a herringbone parlour and are culled. In addition, there is a positive correlation between level of yield and milk flow rate. As milk yields will continue to rise in the future, so mastitis susceptibility also will rise. Future cases of mastitis are therefore inevitable. However, if we can learn to house, manage and feed our cows so that the mastitis risk is reduced and their immune response is uncompromised, then the problem can be minimized.

## Fertility

When cattle are confined, many aspects of fertility are affected by the environment. One factor is the effect of stress on conception rates. It is well known that initial embryo fertilization rates are high, but embryo losses occur primarily during the first 3 or 4 weeks following insemination. Approximate figures for 100 cows inseminated would be:

- 95 cows pregnant at day 3
- 90 cows pregnant by day 10
- 60 cows pregnant at day 21
- 50 cows pregnant at day 42.

There is therefore a very high rate of embryo loss between 10 and 21 days. This is considered to be due to failure of the dam to recognize that she is pregnant. This leads to natural prostaglandin production and expulsion of the fetus. It is considered that environmental stress, in the widest sense of the word, is one reason why the foetal signals are not recognized.

## Environment and General Considerations

Whether the housing system is cubicles or loose yards, there are several general points which are important to reduce environmental diseases:

- poor free-stall (cubicle) design and comfort can lead to excess standing, which predisposes to lameness and traumatic teat injuries.
- a generally harsh environment, for example a heifer introduced into overcrowded yards or into a free-stall building with blind-ended passages, can lead to fear and stress. This, in turn, produces immunosuppression and predisposes to disease.
- diets producing loose feces will increase contamination of teats and feet, predisposing to mastitis and lameness. In calf housing, wet feces exacerbate the risk of pneumonia and scours.
- exposure to cold and windy conditions, especially when teats are damp, leads to poor teat skin condition and development of cracks and chapping. This predisposes to mastitis.
- for housed animals, whatever bedding is used should be clean and dry.

Cows are extremely "damp" animals, having a high water output. Wathes (1990) estimated daily water excretion for a high-yielding, 600-kg cow to be:

| Source of water loss | Conditions | Loss in litres per day |
|---|---|---|
| Cutaneous | thermo-neutral | 2.0-2.5 |
| | hot | 10.5 - 22.5 |
| Respiratory | thermo-neutral | 2.0 |
| | hot | 9.0 |
| Feces | lactation | 30.0 |
| | pregnancy | 21.0 |
| Urine | lactation | 21.0 |
| | pregnancy | 19.0 |

A high-yielding, lactating cow in a hot environment would therefore be giving off up to 83 litres of water per day. Even in a thermo-neutral environment, daily water excretion would be 55.6 litres per cow - or 5,560 litres per 100-cow herd! Whatever the housing system, it should be constructed and managed to remove as much of this water as possible. The important factors are:

- adequate drainage
- frequent scraping to remove urine and feces
- good ventilation
- minimizing stocking densities
- providing diets which produce a reasonable fecal consistency.

Storing bedding material outside, whether it be sand or straw, is unacceptable. In the UK, round straw bales are sometimes stored outside, particularly those covered by netting. Many farmers assume the water will run off the outside of the bale, but this is not the case. If the stack is examined in detail, a layer of damp will be found running between the bales, even in the center of the stack. This leads to a general dampness of the straw, which will absorb less of the moisture produced by the cattle, thereby predisposing to mastitis and/or calf pneumonia. In addition, if there is fungal or mould growth, then yeast mastitis and calf pneumonia are even more probable. Recently Hughes (1998) showed that if straw is baled damp, for example at night or with a very light mist present, then the moisture content can reach 25%, even in the center of the bale. This compares unfavorably with normal straw, where the moisture content should be 10%-15% maximum.

## Free Stalls

Free stall design and management are vitally important in the etiology of both mastitis and lameness. In a grazing situation, cattle all feed together and then lie down together. Therefore there should be enough free stalls available to allow at least one per cow, preferably with a 10% surplus to allow some freedom of choice. Heifers either should be trained to use the free stalls well before calving, or if this is not possible, they should have a 4 to 6-week postpartum period in straw yards before entering the main system. One final general point is that they should be sufficiently comfortable to encourage use. If cows lie down in the passageways, the risk of environmental contamination is enormous.

Much has been written about the ideal free stall design and dimensions, and it is not the intention of this article to review this. However, the main features are:

- 7 feet 6 inches long and at least 3 feet 9 inches wide
- a brisket board should be placed 5 feet 8 inches from the curb to stop the cow going too far forward
- free stall divisions should minimize trauma to the cow. Probably a cantilever design, with no vertical bar at the rear, is ideal.

The most important feature of free stalls is comfort, with sufficient padding to reduce trauma to the cow's knees and hocks on the concrete base. To appreciate the importance of this comfort, it is necessary to understand how a cow rises to stand. The first movement is a lunge forward as she lifts herself onto her hind legs. Her weight is then taken on both front knees. One front leg is then lifted and swung forward. At this stage all her weight is taken on one knee. Hence, the extreme importance of padding at the front of the free stall to give adequate comfort. This padding can be achieved either by use of well-padded mattresses, or simply by converting the front half of a free stall into a mini straw yard, to make individual cow "free stalls" or "cow nests".

The latter may be achieved by sweeping the straw away from the front of the concrete base and substituting rotting straw yard muck to a depth of about 9-12 inches, then covering this with clean straw. The cows will rapidly compact the fermenting bedding and key it into the concrete floor. Freshly applied bedding will be held in place by the lower layers of dry, but compacted bedding and a near-perfect environment is produced.

### Attention to the Rear of the Free Stall

It is vital that the rear end of the free stall be kept clean and dry. Wet areas and feces should be removed at least twice daily, or every time the herdsman walks through the house. In addition, the use of a handful of slaked lime (calcium hydroxide) applied to the rear of each free stall twice weekly, then covering this with bedding, will help keep the bed dry. If mats or mattresses are used, it is essential that they also receive a handful of bedding every day. Failure to do so not only causes hock sores, due to excess rubbing or friction of the skin against rubber, but because the mats are damp they can predispose to mastitis.

### Types of Free Stall Bedding

The type of bedding chosen will depend on cost and availability, and also the type of channel-cleaning system. If the channel has slats, or automatic scrapers, only very limited amounts of chopped straw can be used. Sand also can clog the slurry system and unless very deep, can be uncomfortable.

If you are in doubt, press your knuckles into the sand. If there is insufficient sand, it is amazing how quickly it pushes away and your knuckles impact on the concrete cubicle base; a cow's knees will do the same. However, sand supports a much lower level of bacterial growth. Straw beds predispose to *Streptococcus uberis* infections and if stored damp, sawdust can lead to coliform mastitis (Table 1).

**Table 1.** Coliform levels using different housing systems.

| Group | Housing system | Number of coliforms/g bedding | Cases of coliform mastitis |
|---|---|---|---|
| 1 | Sand cubicles | 37,000 | 0 |
| 2 | Straw yards | 47,000 | 0 |
| 3 | Well-managed sawdust yards | 44,000 | 0 |
| 4 | Poorly managed sawdust yards | 66,000-69,000 | 7 |

In some areas, straw is less readily available and therefore more expensive. However, it still is cheaper than the cost of a case of mastitis. In the UK, the average straw usage for free stall-housed cows is 450 kg per cow per winter and so the difference between $82 per ton and $58 per ton is only $11 per cow/year ($37 vs. $26) - whereas a single quarter affected by mastitis is considered to cost around $150!

### Straw Yards

As with free stall housing, the design of straw yards has a big impact on their function. Ideally they should be no more than 25 feet deep, with the water trough sited at the front.

If the water is at the rear, the cows will have to traverse the whole yard for water. They are likely to soil the area around the trough and if the trough leaks, the yard is likely to become flooded.

There are varying opinions on whether the whole front of the yard should be open to the cows, or whether an access area on each side is adequate. The latter causes more soiling at the entrance, but there may be an overall area of cleaner straw. Minimizing stocking density and maximizing ventilation are essential. Space allowances should be at least 75 square feet per cow (50 square feet bedded and 25 square feet loafing area) and the larger, high-yielding Holsteins should be allowed up to 80 square feet per cow (6m/ bedded and 2m/ loafing and feeding).

### Frequency of Bedding Change

Frequent changing of the bedding appears to be vital for straw yards in relation to mastitis. If bedding is allowed to build up it will ferment, heat up and give off gases and humidity. The temperature of the upper layer of wet straw, just below the dry straw surface, then reaches a constant 104°F (40°C). The steam given off when yards are cleaned on a cold, frosty morning is a good indication of the amount of water vapor being excreted! Composting does not support the growth of significant amounts of *Escherichia coli* or *Streptococcus uberis* in the lower levels of the bed, but the heat and water vapor emitted encourage both organisms to proliferate on the surface and increase mastitis risk.

Most dairy farmers clean out and renew the bedding in the yards every 4 to 6 weeks. Some do this every 3 weeks; others, as soon as mastitis incidence starts to rise and a few, every 2 weeks. There is unlikely to be a correct frequency because it will depend on such factors as:

- stocking density
- environmental temperature and humidity
- quality of straw used for bedding
- ventilation
- drainage

- frequency of scraping of feed passages
- diet, and therefore fecal consistency
- approximate stage of lactation.

There is an urgent need for development of an indirect way to assess surface bacterial burdens, thus enabling farmers to be pro-active, rather than reactive, in renewing the bedding. If cleaning frequency is increased to once every 2 weeks, then composting is virtually eliminated. The importance of straw quality and storage conditions was covered earlier in this article.

### Confinement, Environment and the Dry Period

Recent work has shown the extreme influence of the environment during the dry period on the incidence of clinical mastitis during the next lactation, particularly coliform mastitis. It has long been established that a significant number of new infections are contracted during the first 2 weeks and last 2 weeks of the dry period. Of course there are almost an equal number of infections which are "lost", i.e. undergo a spontaneous self-cure. This occurs particularly during the second third of the dry period, when levels of lactoferrin and NAGase are highest.

*Streptococcus uberis* is a common new infection and may remain dormant in the udder until lactation, when it develops into a clinical case. Chronic recurrent clinical cases of *S. uberis* could therefore arise from a new infection either in the dry period or during lactation.

Recently Bradley and Green (1998) showed that *E. coli* behaves in a similar way, in that new infections contracted during the dry period can lie dormant and cause clinical mastitis during lactation. Of the 700 dry-cow quarters sampled, 619 were negative for *E. coli* and of these, only 1.8% developed coliform mastitis during the subsequent lactation. However, of the 81 quarters which cultured positive, 14.8% developed *E. coli* mastitis during lactation.

Almost 70% of overall cases of *E. coli* mastitis occurring during lactation are now thought to originate in the dry period. Many of these *E. coli* infections are contracted during the last 7-14 days of the dry period. For example, with experimental *E. coli* infection (Hill 1990), 22% of cows infected at 20-27 days prepartum develop clinical mastitis in lactation, in contrast to 39% of cows infected in the last 10 days.

It is not yet known which environmental and other factors contribute to a high incidence of new dry-period infections with *S. uberis* and *E. coli.* Logic suggests hygiene and formation of an adequate teat seal both are important. Factors to consider are:

- maintain a clean, hygienic environment, especially during the critical first and last 2 weeks of the dry period. Especially avoid dirty/slurry areas around water troughs and feed bunkers.
- during hot weather, rotate cows around a variety of dry cow paddocks. If they all lie in the same place for much of the time then *S. uberis*, originating from the vagina, inguinal and axial regions, will build up to high levels on the ground.
- apply a thick teat disinfectant, preferably a barrier dip, immediately after the administration of dry cow therapy and consider repeating this every few days during the immediate pre-calving period.
- always handle dry cows gently, especially during the first fortnight following drying off. If they are rushed when being moved and their udders are full of milk, sudden jolting movements may break open the teat seal.
- milk out cows within 24 hours of calving. Leaving the calf with the cow will not achieve this, and failure to strip out a quarter considerably increases the risk of mastitis. Milk fever should be controlled by diet, not incomplete milking.

### Summary

The interaction between the cow and her environment involves comfort, stress and hygiene. Within conditions of confinement these interactions become even more important and the risk of disease is considerably increased. All 3 factors must be improved if we are to capitalize on the output from our high-genetic cows.

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