A rational approach to dry cow therapy
1. Udder health priorities during the dry period

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IN all areas of medicine, the appropriate use of antimicrobial agents has become a subject of much interest and debate. Concerns over the misuse of antibiotics centre on the possible build up of bacterial resistance and a fear of residues entering the food chain. The veterinary surgeon plays a pivotal role in the way in which antibacterial agents are used on the dairy farms under his/her care and dry cow therapy is probably the most commonly prescribed antibiotic product, with almost 4 tonnes of active ingredients being used in the year 2000. As with all medicines, it is essential that dry cow therapy is prescribed on a rational basis. The aim of this two-part article is to describe current knowledge on udder health in the dry period and to use this to develop a logical approach to prescribing dry cow therapy. Part 2, which will be published in the next issue, will provide guidance on product selection.

PHASES OF THE DRY PERIOD

The dry period is the time between the last milking of one lactation and calving at the start of the next lactation. Research suggests that excessively short (four-week) and long (10-week) dry periods are detrimental to udder health (Enevoldsen and Sorensen 1992), although 50 to 70 days has been identified as the optimal dry period from the point of view of milk production (see graph below). Decreasing the length of the dry period results in a decreased yield in the subsequent lactation, whereas excessively long dry periods decrease lifetime yields and can lead to problems with cows becoming too fat at calving. The dry period is occasionally lengthened in response to a premature reduction in milk yield or in an attempt to reduce herd milk output because of quota constraints.

During the dry period the mammary gland undergoes a series of changes that influence the cow’s resistance to bacterial infection. These are described below.

INVOLUTION
The transition from a lactating to a fully involuted, dry gland can take three to four weeks. For several reasons, this is a time of increased risk of bacterial infection:

■ There is initially an increase in intramammary pressure when milking stops, and this leads to widening of the streak canal and teat orifice;

■ The regular removal of milk stops and therefore the physical effect of flushing bacteria that penetrate the mammary gland ceases;

■ There is a cessation of teat hygiene procedures (e.g. teat cleaning/dipping) that reduce the risk of new infections;

The graph below shows the effect of length of dry period on a cow’s milk production in the next lactation, as compared to herdmates.

**Effect of length of dry period on a cow’s milk production in the next lactation, as compared to herdmates**
Natural defence mechanisms that operate in the involuted gland (see below) take days or weeks to become fully established and are therefore not yet at their most effective:

- Leucocyte function is impaired by the presence of large amounts of milk fat and debris that are resorbed following the cessation of milking.

FULLY INVOLUTED (‘STEADY STATE’)

Once involution is complete, the mammary gland takes on an empty, ‘flabby’ appearance and is relatively resistant to bacterial infection. The various factors that promote resistance to infection in the so-called ‘steady state’ are described below.

- High lactoferrin levels tend to inhibit bacterial multiplication mainly by reducing the availability of iron to bacteria. However, some bacterial species (most notably *Streptococcus agalactiae*) are able to bind iron in preference to lactoferrin and are therefore capable of thriving. It is likely that different strains of other bacteria, such as the coliforms, will also have differing abilities to sequester iron from lactoferrin.
- As well as higher lactoferrin concentrations, there is also an increase in the lactoferrin: citrate ratio in the steady state. Both of these molecules compete for the binding of iron; however, because the iron bound by lactoferrin is relatively less available to bacteria, this change in ratio serves to further reduce its bioavailability.
- Lower fat and casein levels mean that the mammary environment is conducive to efficient leucocyte function.
- Intramammary pressure remains low and the teat canal and orifice close. However, research has indicated that 20 per cent of quarters may not have an adequate keratin plug after 30 days of the dry period and around 5 per cent never form an adequate plug throughout the dry period (Williamson and others 1995) (see graph at the top of the page). The same study also found that 97 per cent of all new dry period intramammary infections occurred in these quarters.

COLOSTROGENESIS

As the mammary gland prepares for the next lactation, many of the processes that provide resistance to infection are reversed:

- Intramammary pressure increases as colostrum is produced;
- The concentration of leucocytes decreases and their functional capacity deteriorates;
- Lactoferrin levels are reduced;
- Antibiotic levels in mammary secretion have already been depleted and may be diluted to levels below the minimum inhibitory concentration (MIC) as colostrum collects in the gland.

PREVALENCE OF BACTERIAL INFECTIONS DURING THE DRY PERIOD

Bacterial intramammary infections during the dry period have been studied since the 1940s. It is now recognised beyond doubt that the presence of infection during the dry period has a fundamental and lasting influence on cow health and productivity. The specific effects are:

- A reduction in subsequent milk yield in infected quarters;
- A reduction in milk quality (increased somatic cell counts [SCCs] and decreased butterfat and protein) in the next lactation;
- A greater risk of subsequent clinical mastitis.

The levels of infection with different bacterial species in cows receiving antibiotic dry cow therapy, as determined by two dry period studies, are illustrated by the graphs below.

- A reduction in milk quality (increased somatic cell counts [SCCs] and decreased butterfat and protein) in the next lactation;
- A greater risk of subsequent clinical mastitis.
Dry period infections are a result of either infections carried into the dry period from the previous lactation or new infections acquired during the dry period. Research indicates that the vast majority of infections in the late dry period are newly acquired rather than persisting from drying off (see graphs on the left). Although persistence is generally rare, Gram-positive bacteria are more likely to persist through the dry period than Gram-negative bacteria. Experimental work by McDonald and Anderson (1981) showed that inoculation of *Escherichia coli* into the mammary gland in the early dry period usually resulted in removal of bacteria by the host; this is supported by findings from a recent field study in the UK (Bradley and Green 2000).

New infections during the dry period are extremely important and have been shown to occur at up to 10 times the rate of new infections during lactation (see graph below). *E. coli* and *Streptococcus uberis* are usually the most common causes of new infections and research suggests that over 60 per cent of new infections caused by these organisms occur at this time. Other major pathogens have also been found to cause new dry period infections (see graph on the left) – even those generally considered to be ‘contagious’ in nature and thought to be principally spread during milking. The times of greatest risk of new intramammary infections during the dry period are, as already discussed, involu- tion and colostrogenesis. The diagram at the top of the facing page illustrates the times of susceptibility and resistance of the mammary gland to coliform infection.

The reason why clinical mastitis is not common during the dry period, even though many new intramammary infections occur, is probably because the mammary environment is not conducive to bacterial growth. However, although high lactoferrin and leucocyte concentrations do not allow rapid bacterial multiplication, it is a common misconception that these intramammary conditions stop infections from occurring at all during the dry period. Bacterial infections do occur during the dry period but are not usually seen as clinical cases in the dry period. Most infections remain subclinical until after calving and, even then, some do not cause clinical disease.
**Drying off**

**Calving**

**Dry period infections and clinical mastitis**

Bacterial infections present during the dry period have a fundamental influence on the amount and pattern of clinical mastitis that will be seen on a dairy unit. In some herds, over 60 per cent of all clinical mastitis cases can be traced to bacterial infections that originate in the dry period and, therefore, management policies at this time can have a significant impact on the incidence of clinical as well as subclinical mastitis. It is rare for bacterial infections to cause clinical disease in the dry period, although species associated with summer mastitis are an exception.

Research has shown that clinical mastitis that arises from infections acquired during the dry period occurs at a faster rate after calving than clinical mastitis arising from infections acquired during lactation (Green and others 2002). Dry period infections tend to become clinical within one month of calving, whereas clinical mastitis contracted during lactation tends to occur at a more even rate (see graph, above right). This means that plotting the incidence of clinical mastitis and observing the pattern in a herd will give an indication of the impact of dry period infections. Molecular techniques (DNA fingerprinting) have recently been used in the UK to follow strains of *E. coli* and other Enterobacteriaceae from the dry period to clinical cases of mastitis, to confirm this link (see below).
PREVENTION OF DRY PERIOD BACTERIAL INFECTIONS

Dry cow therapy has an important role to play in the treatment and prevention of dry period infections, but it is essential to remember that other management strategies are equally important in preventing mastitis. Such strategies include maintaining environmental conditions to reduce bacterial challenge, fly control, good dry period nutrition, and minimising ‘stresors’ such as frequent moving of cows between groups, climatic extremes and poor feed access.

BASIS FOR PRESCRIBING DRY COW THERAPY

The ultimate aim in prescribing dry cow therapy is to ensure that each cow receives the most suitable dry cow formulation. This requires an understanding of the causes of clinical and subclinical mastitis on a dairy farm and the antibiotics available (these will be discussed in Part 2).

A number of techniques can be used to acquire the necessary background information on which to base a logical approach to dry cow therapy, and these are described below.

DRYING OFF: INFECTED VERSUS UNINFECTED COWS

In the modern dairy herd, at the time of drying off a minority of cows will be infected with a major pathogen and the majority will be uninfected. These two groups of cows have different requirements: the aim for infected cows is to cure existing intramammary infections; the aim for uninfected cows is to prevent the acquisition of new intramammary infections. It may therefore be necessary to prescribe two different products to meet the different requirements of the two groups.

Key questions to consider for an individual farm are:

- Which bacterial species are responsible for chronic, subclinical infections and are likely to be present at drying off?
- Which bacterial species are causing new infections in the dry period and are therefore responsible for cases of clinical mastitis and high SCCs after calving?

IDENTIFYING CHRONIC, SUBCLINICAL INFECTIONS

In order to select a product suitable for infected cows, it is important to gain knowledge of the pathogens present. This can be done in several ways at herd and/or cow levels.

Herd level

Performing regular bacteriology on bulk tank samples is simple and relatively cheap, but is not to be recommended as a basis for making decisions on dry cow therapy. This is because identification of a bacterial species in bulk milk does not necessarily mean it has come from an infected quarter – it could be a skin or environmental contaminant. This is certainly true for commonly isolated bacteria such as S. aureus, Staphylococcus auritus and E. coli; as an ‘obligate’ udder pathogen, discovery of S. agalactiae is of greater significance and will have an influence on many decisions, including that of dry cow therapy. Furthermore, isolation of a bacterial species from bulk tank milk gives no quantitative information regarding the prevalence of infection within the herd. However, the bulk milk somatic cell count will give an indication of the levels of subclinical mastitis in the herd and can be used as an aid to setting priorities for dry cow therapy selection.

Cow level

Direct bacterial culture from infected cows provides a specific means of identifying the pathogens involved in subclinical mastitis. Individual cow SCCs will assist in identifying infected cows: an SCC of over 200,000 cells/ml for three consecutive recordings suggests that one or more quarters is likely to be infected. The infected quarter(s) in these cows can then be identified using the California Milk Test or individual quarter somatic cell counting.

Bacterial culture of milk samples from infected quarters will often reveal the species involved and this is best performed by an accredited laboratory meeting recognised standards for identification of mastitis pathogens. The selection of cows for sampling is important. To maintain an up-to-date farm picture, it is useful to sample around six to 10 high SCC cows/100 cows/year. These milk samples can be frozen and dispatched to the laboratory in batches (see box, below left); most laboratories offer a proportionately cheaper rate for batches as opposed to individual samples.

IDENTIFYING THE CAUSE OF NEW INFECTIONS IN THE DRY PERIOD

Since new dry period intramammary infections often result in clinical mastitis as well as high cell counts after calving, bacteriology of clinical cases is another valuable source of information. Farmers will need to be trained to collect non-contaminated samples, but this is straightforward. The provision of a kit to be kept near the milking parlour is helpful. This should include a dip trip solution, surgical spirit, sterile pots with labels, and a laminated card with instructions on how to take a good sample (see box on the facing page). Samples from clinical cases need to be collected before treatment, using sterile pots marked with the date and the identity of the cow/quarter, and then frozen, before submitting to a laboratory in batches.

Use of frozen milk samples for diagnosis

- Milk samples should be taken aseptically prior to treatment of clinical cases or from high cell count quarters
- Samples should be stored carefully in a freezer and handled as potentially dangerous to human health
- Thawing should be carried out slowly at room temperature or in a refrigerator overnight
- Culture should be carried out within a month of freezing, unless a cryopreservative is used
- Recovery of bacteria is generally good. Detection of Gram-positives pathogens is enhanced after freezing; Gram-negative organisms will generally suffer no more than 15 per cent false negatives
- Recovery can be enhanced by using a cryopreservative such as glycerol or dimethyl sulphoxide (DMSO)

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Collection of a milk sample

- Clean and dry the teats, as necessary, to remove gross contamination
- Predip (with proprietary predip solution); allow 30 seconds contact time before drying
- Thoroughly clean and disinfect the teat by scrubbing with cotton wool soaked in 70 per cent alcohol, then allow to dry
- Strip quarters approximately six times
- Again clean and disinfect the teat by scrubbing with cotton wool soaked in 70 per cent alcohol, then allow to dry
- Take milk sample by stripping milk horizontally into a sterile pot. Ensure the pot does not become contaminated by holding it in an inverted position before moving it into a horizontal position to catch the milk
- Label the pot immediately after replacing the lid
- Carefully administer an intramammary tube, if required, and dip the teat in an effective germicidal product
- Confine the cow to a loafing yard/area for approximately 30 minutes to allow closure of the streak canal

ONGOING MONITORING

Drawing on all of the available records and supplementing this with strategic bacteriology of high SCC cows and clinical cases, it is possible to gain an insight into the epidemiology and aetiology of mastitis on an individual dairy unit. Continued monitoring of the herd in this way is a vital component of rational prescribing of both lactating and dry cow intramammary products.

WE KNOW THE BACTERIA – NOW WHAT?

Knowledge of the main pathogens on a farm helps in deciding on the type(s) of dry cow therapy that are appropriate. This may vary between cows within a herd, or even at different times of the year. All this information will be used to derive a logical approach to the prescription of dry cow therapy in Part 2, to be published in the next issue.

References


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