

Giving Dry Cow Mastitis the Boot

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Introduction

Despite decades of research and steady progress to improve our knowledge of mastitis control methods, mastitis remains the most costly infectious disease affecting dairy herds today. Fetrow et al. (2000) estimated that an average upper Midwest dairy loses roughly \$200 per cow per year. These losses are due to:

- Lost milk production associated with elevated SCC (17% of losses).
- Lost income from SCC premiums (36% of losses).
- Direct losses from clinical mastitis (12% of losses).
- Losses from excess culling and death (35% of losses).

It is evident that most producers still have a tremendous opportunity to reduce mastitis in their herds, which should result in both improved cow health and economic performance.

Mastitis control strategies over the past four decades have resulted in a reduction in the prevalence of contagious mastitis pathogens, but an increase in the relative importance of environmental pathogens such as *Escherichia coli* and *Streptococcus uberis* (Bradley and Green, 2004). Furthermore, the dry period is a very high risk period for the acquisition of new environmental intramammary infections (IMI), with over 60% of new IMIs occurring at this time. A majority of new IMIs occurring during the dry period will be caused by major environmental pathogens such as *Escherichia coli* and *Streptococcus uberis*, as well as minor pathogens such as Coagulase negative staphylococci. In one U.S. study, the risk for new IMI from environmental organisms, including coliforms and environmental streptococci, was up to ten times higher than during the lactation period (Smith et al., 1985). These infections rarely cause clinical mastitis during the dry period, but frequently persist as subclinical infections into the next lactation, resulting in elevated SCC, associated subclinical losses in milk yield, and frequently causing clinical mastitis early in the next lactation. One U.K. study demonstrated that over 50% of all clinical mastitis cases caused by environmental pathogens occurring in early lactation (first 100 days in milk) resulted from infections acquired during the dry period (Bradley and Green, 2000).

Host-Defenses Affecting Susceptibility to Intramammary Infection During the Dry Period

While the fully involuted gland is considered to be very resistant to new IMI, the gland is particularly susceptible to new IMI during the first 2 to 3 weeks after dry off (correlating with involution), and during the last 2 weeks prior to calving (correlating with colostrogenesis).

During involution, the gland is at increased risk for new IMI due to the cessation of flushing bacteria from the streak canal, the discontinuation of teat dipping, and compromise of the streak canal due to increased intramammary pressure from milk build-up. Finally, there can be a significant delay in the formation of a complete keratin plug in the streak canal. A recent North American study reported that 50% and 23% of teats failed to form a complete keratin plug after 1 week and 6 weeks dry, respectively. Also, teats with an incomplete keratin plug were 1.8 times more likely to develop a new IMI during the dry period (Dingwell et al., 2003).

During the transition to colostrogenesis, the mammary gland again becomes more susceptible to IMI because concentrations of protective factors become diluted, the keratin plug may break down, and immune function may be impaired. Coupled with this, antibiotic concentrations in quarters that received antibiotic dry cow therapy (DCT) at dry off have dropped below the minimum inhibitory concentration (MIC).

Strategies to Prevent New Intramammary Infection During the Dry Period

The two main principles involved in preventing new IMI during the dry period must be: 1) minimize the challenge from pathogens in the environment, and 2) maximize (and supplement) the cow's own defenses. Strategies available to address these two important principles of mastitis prevention during the dry period include:

Antimicrobial Dry Cow Therapy

Blanket antibiotic DCT continues to be a standard recommendation in North American dairy herds. However, protection will be incomplete because DCT will not prevent new IMIs caused by resistant pathogens, or new IMIs occurring during the colostrogenesis period when antibiotic levels have dropped below the minimum inhibitory concentration (MIC).

External Teat Sealants

Once applied, these products dry to generate a latex, acrylic or other polymer-based film over the teat that prevents entry of pathogenic bacteria into the teat canal. Examples of commercially available external teat sealants include Stronghold™, Drycow™, and DryFlex™ (West Agro, Inc./DeLaval). Several studies have reported a protective effect of using external teat sealants, either in conjunction with antibiotic DCT, or used alone.

One drawback to using external teat sealants is the relatively short duration of adherence, with studies showing a median of 6 days duration of protection (range 4 to 9 days). This requires that dipped teat ends be frequently reexamined, and the dip frequently reapplied, in order to maintain an effective barrier. Producers using an external teat seal should plan a routine schedule that dips at dry off, and then again as needed starting approximately 10 days precalving, to ensure continuous covering until calving occurs. This may require examination and reapplication two or three times during the last week precalving.

Internal Teat Sealants

An alternate management tool that has just recently been introduced to North America is an internal teat sealant. OrbeSeal™ is an internal teat seal consisting of bismuth subnitrate in a paraffin base (65% w/w, 2.6 g in 4 g) (Pfizer Animal Health). This inert viscous paste is infused into the quarter at time of dry off forming an immediate physical barrier in the distal portion of the teat cistern to prevent bacteria from ascending through the teat canal. Insoluble in milk, it has no antimicrobial properties and no residue or food safety risks (C.V.M.P., 1999). The majority of the OrbeSeal™ product is stripped out at first milking after calving, with some residual product removed in subsequent milkings after calving.

One recent North American study was designed to describe the effectiveness of OrbeSeal™ in the prevention of new IMI during the dry and early lactation period when used with DCT at dry off. A total of 437 cows (1748 quarters) from two large dairy herds, with no clinical mastitis

and four functional quarters, were enrolled at dry off. Prior to the final milking before dry off, all quarters were sampled for bacteriological culture and SCC analysis. After the final milking all four quarters were infused with a commercially available long-acting dry cow antibiotic (Orbenin-DC™; Cloxacillin [benzathine], 500 mg; Schering-Plough). Two contra-lateral quarters (LF/RH or RF/LH) were then infused with an internal teat seal (OrbeSeal™, Pfizer Animal Health). Following calving, the teat seal was stripped out at first milking. Duplicate milk samples were collected between 1 to 3 DIM and again between 6 to 8 DIM for culture and SCC analysis. The results of this study showed that quarters treated with OrbeSeal™ plus DCT were 30 % less likely to develop a new IMI during the dry period, 33% less likely to experience a clinical mastitis event between dry off and 60 DIM, and had significantly lower LS than quarters treated with DCT alone (Godden et al., 2003). Other recent multi-site and multi-herd studies conducted in the United States and Canada have shown similar benefits to using OrbeSeal™ (Cook et al., 2004; Sanford et al., 2004).

To summarize, internal teat sealants offer an innovative addition to the dry cow udder health program that may be useful as a sole DCT in uninfected cows, or as an adjunct therapy with antibiotic DCT in infected cows. They offer an advantage over external teat sealants, in that they need only be infused once at time of dry off. The major disadvantage of combining antibiotic DCT with use of a teat sealant will be cost. While it is likely that the cost of this combined strategy may be more easily justified in herds experiencing a moderate-to-high incidence of new IMI during the dry period, the general cost-effectiveness of this strategy still requires investigation.

Minimizing Intramammary Challenge

Environmental mastitis pathogens such as coliforms and environmental streptococci not only survive but multiply rapidly in warm, moist environments when sufficient organic material is available to support bacterial growth (e.g. soil, manure, and organic materials such as shavings or straw). Thus, management efforts to provide a clean, dry environment, excellent cow comfort, and excellent ventilation will be just as important for mastitis prevention in dry cows and heifers as for lactating cows.

Improving ventilation in dry cow facilities will reduce moisture buildup and bacterial growth as well as help to facilitate cow cooling during the hot summer months. As with milking cows, strict attention must be paid to the daily maintenance of bedding, the stall bed, and stall partitions for dry cows. If dry cows and heifers are managed in groups in lots, yards, or bedded packs, then wet soiled bedding must be removed frequently, and clean dry bedding added liberally and frequently in order to reduce contact between wet contaminated bedding and the teat end. Selection and proper maintenance of inorganic bedding materials such as sand can also prevent or reduce pathogen growth, and so reduce pathogen exposure to the teat end.

Maximizing Host Defenses

Maximizing the cow's immune function will result in more rapid elimination of new infections, and a decrease in the frequency, duration, and severity of clinical mastitis episodes. Unfortunately, it is very common for the immune system to be suppressed in the periparturient cow.

Nutrition and Feeding Management

One requirement for improving immunity is to provide optimal nutrition throughout the dry and transition period (Spain and Scheer, 2004). For example, relationships have been established between vitamin E and selenium status and the incidence of mastitis (Jukola et al., 1996; Smith et al., 1997). Dry and transition diets should contain the recommended levels of dietary protein, energy, vitamins and minerals (e.g. vitamins A, D, and E, selenium, copper, zinc) according to NRC (2001) guidelines. Negative energy balance, associated with ketosis, and the number of feed spaces per cow have also been related to the severity or incidence of E. coli mastitis, respectively. In addition to monitoring nutrient density of the diet, feeding management should be such that dry matter intakes are not restricted during the dry and transition period. This will require good feedbank management and ad libitum access to fresh, high quality, feed and water, as well as avoiding stressors such as overcrowding, providing excellent cow comfort, good ventilation, heat abatement, and minimizing group (social) changes during the transition period.

Vaccination

One of the most promising methods of enhancing mammary resistance for coliform (and all gram-negative) IMIs is by use of core antigen vaccination. California studies demonstrated that cows receiving two vaccine doses during the dry period and one dose after calving had an incidence of clinical coliform mastitis of 2.6%, as compared to 12.8% in unvaccinated controls (Gonzalez et al., 1989). Subsequent field studies from Ohio have confirmed the benefits of this technology. Vaccination with core antigen bacterins does not reduce the number of new dry period coliform IMIs, but has been shown to decrease the incidence and severity of clinical coliform cases, and is beneficial for both heifers and multiparous cows.

Method of Drying Off

Studies investigating the optimal method of drying off cows are limited. However, high milk yield at dry off has been associated with both a delay in teat closure and an increase in the risk of new IMI during the dry period. As such, it should be useful to adopt strategies to reduce yield before drying off, so as to minimize the risk of leaking milk. Such strategies could include intermittent milking (once daily) for the last 2 weeks of lactation, adjusting the energy density of the ration, or limiting water intake. However, the ability to implement various dry off procedures in a given herd will vary depending on the facilities, available labor and management structure of the enterprise.

Summary

The dry period is a high risk period for the acquisition of new environmental IMIs. As such, a successful comprehensive mastitis control program will need to direct significant effort toward management of the dry cow and, in particular, toward preventing new infections through maximizing and enhancing host defenses and minimizing bacterial challenge. Antibiotic and non-antibiotic DCT (e.g. teat sealants) are efficacious management tools that can be strategically integrated into a dry period udder health management program. However, to be successful, a more holistic approach is likely necessary, which will also encompass vaccination programs, housing, environmental and nutritional management of the dry cow.