

## **Managing the Dry Period for Milk Quality**

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### **Introduction**

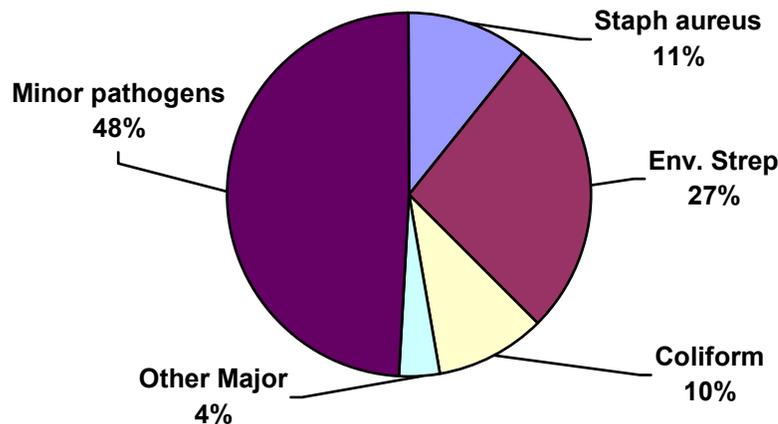
The quality of milk is defined based on the somatic cell count (SCC) and bacterial count of bulk tank milk. Since 1986, the dairy industry has successfully adapted to gradual reductions in allowable regulatory limits for SCC and bacteria. The dairy industry has responded by adopting methods to control contagious mastitis and the prevalence of mastitis caused by *Staphylococcus aureus* and *Streptococcus agalactia* has steadily declined (Makovec and Ruegg, 2002, Philpot, 2002). Even though the rate of contagious mastitis is declining, mastitis remains the most frequent and costly disease of dairy cattle because of increased infections with environmental pathogens. The importance of the dry period in the control of contagious and environmental mastitis and the production of high quality milk is universally recognized.

### **Mastitis Pathogens and the Dry Period**

The importance of the dry period in the control of contagious mastitis has been recognized for more than 50 years (Neave et al., 1950). Many contagious mastitis infections (especially infections caused by *Staph aureus* and *Strep agalactia*) are subclinical and the use of dry cow therapy is a well-established and cost-efficient method of eliminating subclinical mastitis infections. The importance of the dry period in the control of environmental mastitis has been more recently recognized. Important environmental pathogens include Gram-negative bacteria such as *E. coli* and *Klebsiella spp.* and Gram-positive bacteria such as *Streptococcus dysgalactia* and *Streptococcus uberis*. In one study, cows that had environmental pathogens isolated from milk samples at dry off were 4.5 times more likely to have a clinical case of environmental mastitis during the next lactation as compared to cows that dried off uninfected (Bradley and Green, 1999). In that study, most (65%) of the clinical cases of environmental mastitis that occurred during the subsequent lactation were caused by infections acquired during the preceding dry period.

Many pathogens can infect the udder during the dry period. A recent study examined the development of new intramammary infections during the dry period (Dingwell, et al., 2002). Overall, 16.7% of quarters developed intramammary infections during the dry period. A variety of mastitis pathogens organisms were isolated after calving from quarters that had been free of infection when the cow went dry (Figure 1).

Figure 1. Diagnosis of infections acquired during the dry period (Dingwell et al., 2002).



### Risk Factors for Mastitis Infections during the Dry Period

Management of the dry period is recognized as a critical component of udder health programs. It has been estimated that at least 8-12% of quarters that do not receive dry cow therapy will become infected during the dry period (Eberhart, 1986). Most of these infections will not become evident until the next lactation. The importance of the dry period and early lactation is even more evident when SCC values are compared between the last test date before dry off and the first test date in the subsequent lactation (Cook et al., 2002). In that study, approximately 22% of multiparous cows that had SCC <200,000 cells/ml at the last DHI test had developed subclinical mastitis by the first test in the next lactation.

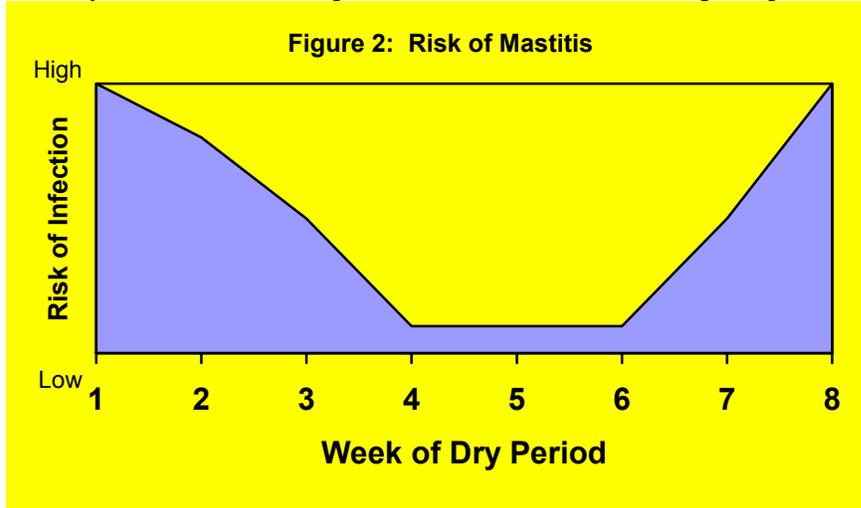
In December 2003, approximately 48% of 1,742 multiparous cows in 8 Wisconsin dairy herds had SCC values indicative of subclinical mastitis ( $\geq 200,000$  cells/ml) at their final test in the previous lactation (Ruegg, 2004 unpublished data). All of the herds used routine intramammary dry cow therapy. When SCC values for the last test before dry off were compared with SCC values for the first test in the next lactation, 37% were uninfected at both tests, 21% were infected at both tests, 27% were infected only at the last test and 15% had dried off uninfected but had developed new infections by the first test. Cows that dry off with high SCC values have a higher probability of subclinical mastitis in the next lactation. Each 100,000 cell increase in SCC at the last test resulted in a 2-fold increase in the probability of subclinical mastitis in the next lactation ( $P < 0.001$ ). Subclinical mastitis in early lactation had a dramatic effect on milk yield. Average lactation linear scores were higher and milk yields were decreased for animals that had SCC  $> 200,000$  cells/ml at both test dates (Table 1)

Table 1. Effect of subclinical mastitis at dry off and early lactation on yield and linear score for cows in 8 Wisconsin dairy herds (Ruegg, 2004, unpublished).

Status at Last Test in previous lactation	Status at First Test in current lactation	N	Average Lactation Linear Score in next lactation	305 day Mature Equivalent Milk
SCC < 200,000	SCC < 200,000	628	2.4 <sup>a</sup>	10,096 kg <sup>a</sup>
SCC $\geq$ 200,000	SCC $\geq$ 200,000	359	5.6 <sup>b</sup>	8,952 kg <sup>b</sup>
SCC $\geq$ 200,000	SCC < 200,000	469	2.9 <sup>c</sup>	9,866 kg <sup>a</sup>
SCC < 200,000	SCC $\geq$ 200,000	270	4.8 <sup>d</sup>	9,820 kg <sup>a</sup>

<sup>a,b,c,d</sup> values in the same column with different superscripts are significantly different,  $P < 0.05$

The risk of developing mastitis is not evenly distributed throughout the dry period. The beginning and the end of the dry period are high-risk periods for development of intramammary infections (Figure 2). During the early weeks of the dry period, the udder is many times more susceptible to infection than during the preceding lactation.



A number of factors contribute to increased susceptibility to infection during the early and late dry period. Mastitis develops when exposure to mastitis pathogens overwhelms the immune system of the udder. Termination of milking practices (such as forestripping and predipping) allows increased growth and exposure to bacteria on teat skin and in the streak canal. The streak canal becomes shorter after milking is terminated and the development of a physical barrier to infection (the keratin plug in the streak canal) is not immediate. The development of the keratin plug is an important intramammary defense. Data from both New Zealand and North America have demonstrated that the keratin plug has not yet formed for 40%, 30% and 24% of dry cows by 2, 4 and 6 weeks after dry off, respectively (Williamson, J. H., et al., 1995, Dingwell, et al., 2003). The development of the keratin plug has been significantly related to production level at dry off. Teats were still open 6 weeks after dry off for half of cows that produced >21 kg of milk on the day before they were dried (Dingwell et al., 2003).

Management of dry cows becomes more important as cows age (Dingwell et al., 2002). The rate of development of new intramammary infection during the dry period was 11.9% (Lactation 1), 20.9% (lactation 2), and 18.9% (lactation 3+) (Dingwell et al., 2002). In December 2003, for 8 Wisconsin dairy herds, the proportion of cows with SCC values  $\geq 200,000$  cells/ml at the first test was 24% (1<sup>st</sup> & 2<sup>nd</sup> lactation; n = 1625), 34% (3<sup>rd</sup> & 4<sup>th</sup> lactation; n=871) and 48% ( $\geq 5^{\text{th}}$  lactation; n=278) (Ruegg, unpublished). Probable reasons for increased susceptibility to mastitis with age include: previous exposure or infection with mastitis pathogens or decreased patency of the teat sphincter.

Dry cows are often housed in less than desirable facilities and there are a number of risk factors for infection that are relating to dry cow management. In a study of 201 dairy farms in the Netherlands, several risk factors for subclinical mastitis were identified (Table 2, Barkema, et al., 1998).

Table 2. Practices of herds with low, medium and high SCC (Barkema, et al., 1998).

	Bulk Tank SCC of Herd (cells/ml x 1000)		
	<150	151 – 250	>250
Udder of dry cow below hock	9.5%	13.5%	15.1%
Use Dry cow therapy – all cows	93.2%	79.5%	76.4%
Check dry cows for mastitis daily	75.3%	57.5%	45.5%
Calving pen straw removed after calving	83.6%	65.8%	56.4%
>30% of the udder covered with manure	0.5%	2.0%	2.2%

Udder cleanliness is an important risk factor for mastitis for both dry and lactating cows. When the teats and udder are wet and dirty, large numbers of these bacteria have the opportunity to infect the udder. Exposure to moisture, mud, and manure in cow housing areas can influence the rate of subclinical and clinical mastitis of both dry and lactating cows. Udder hygiene scores (UHS) can be easily and efficiently obtained using a visual scoring system (Figure 3). This system was used to repeatedly score 1250 lactating dairy cows housed in freestalls on 8 Wisconsin dairy farms (Schreiner and Ruegg, 2003). Cows were categorized as “clean” (UHS of 1 or 2) or “dirty” (UHS of 3 or 4). About 20% of the cows received scores categorized as “dirty.” Somatic cell counts and the rate of intramammary infection were both higher for animals categorized as “dirty.” Each cow with an UHS of  $\geq 3$  has an increased risk of mastitis. When this scale is used, <15% of cows should have UHS of 3 or 4.

### Treatment during the dry period

The use of long acting antibiotic dry cow therapy (DCT) is common throughout the world with estimates of use by 75-99% of producers (Dingwell, et al., 2003). The use of comprehensive DCT is highly adopted in Wisconsin. In a recent summary of management practices of Wisconsin farms (n = 140) participating in quality improvement programs DCT was used on all quarters (92%), or selectively (6%) for almost all farms (Rodrigues and Ruegg, 2004, unpublished). Dry cow therapy has been shown to eliminate up to 80% of existing infections at dry off and prevent up to 80% of new infections during the dry period. The use of antibiotics to treat all quarters of all cows has been questioned in recent years because of concerns about the development of antibiotic resistant bacteria. There is no evidence that use of dry cow therapy contributes to the development of resistance to antibiotics and decreased resistance has been noted for some antibiotics (Erskine et al., 2001, Makovec and Ruegg, 2003). There is however, strong evidence that cows that do not receive dry cow therapy develop more intramammary infections, even when the cows are uninfected before dry off (Table 3).

Table 3. Infection Rate Based on Dry Cow Therapy (Berry and Hillerton, 2000)

	No Dry Cow Treatment	Cephalosporin Dry Cow Treatment
Clinical Mastitis in Dry Period	12 of 134 cows (8.96%)	0 of 117 cows (0.0%)
New Infection at Calving	42 of 122 cows (34.4%)	12 of 117 cows (10.3%)

While DCT remains an effective practice, cure rates for chronic mastitis caused by *Staph aureus* remain relatively low and producers often experiment with additional treatments such as the use of multiple intramammary tubes or systemic antibiotics. Several studies have examined the use of adjuncts to DCT. One study compared the use of a single dry cow treatment using benzathine cloxacillin to use of 3 treatments (dry off, 7-days post-dry off and 14-days post-dry off) with the same product (Cummins and McCaskey, 1987). There was no significant effect of the use of multiple dry cow treatments on the rate of new intramammary infections or the cure rate of existing infections.

At least two-studies have examined the use of systemic antibiotics in cows chronically infected with *Staph aureus*. One study compared the use of intramammary dry cow therapy (300 mg cephalixin benzathine) to the same product plus 11 mg/kg intramuscular oxytetracycline given daily on day 7, 8, 9 and 10 after dry off (Erskine et al., 1994). The cure rate at 60-days post-calving was not significantly different (21.2% and 22.5%) between the groups but this group of cows was older and had long-term chronic infections. A more recent study compared the use of intramammary cephalixin benzathine to two subcutaneous injections of tilmicosin (5 mg/kg at dry off and 4-day later). The cure rate for intramammary treatment with cephalixin was considerably higher (78%) as compared to the cure rate for subcutaneous tilmicosin (9%) (Nickerson et al., 1999). The vast majority of studies do not currently support the use of additional therapies at dry off.

The use of selective intramammary dry cow therapy is often promoted when the prevalence of contagious mastitis in a dairy herd is low and there is concern about the development of antibiotic resistance. Variable results have been reported when selective dry cow therapy is used (Osteras, and Sandvik, 1996). The lack of a reliable test to detect infected quarters is a major obstacle for the successful implementation of these programs. In one study, intensive sampling and a variety of CMT thresholds were used to identify quarters infected with mastitis pathogens (Ruegg and Sekito, 2003). In that study, the ability to recover major or minor mastitis pathogens was low when CMT or a SCC threshold of 200,000 cells/ml was used to predict likely infections (Table 4). Until there is an accurate and cost effective method to detect subclinical infections, the use of selective dry cow therapy will likely be limited to herds with a high tolerance for risk.

Table 4. Ability of CMT to identify infected quarters (Ruegg & Sekito, 2003).

Pathogens	Threshold	% of Infected Quarters Not identified with CMT	% of Uninfected quarters Reacting to CMT	Odds Ratio <sup>a</sup>
Major <sup>b</sup>	Trace+	30%	32%	5.0
	One +	50%	11%	8.4
	Two +	55%	4%	21.1
Minor <sup>c</sup>	Trace+	58%	32%	1.6
	One +	85%	11%	1.5
	Two +	93%	4%	1.9

<sup>a</sup>probability of isolating a pathogen as compared to CMT negative samples; <sup>b</sup>*Staph aureus*, environmental *Streps*, *Coliforms*; <sup>c</sup>coagulase negative *Staph*, *Corynebacterium spp*.

### **Treatment after Calving**

The development of intramammary infections during the dry period has led to the development of additional treatment strategies. Recently, intramammary treatment of subclinical infections present at calving has been promoted. The underlying theory is that early identification and effective treatment will reduce the duration of subclinical mastitis infections, reduce episodes of clinical mastitis and be financially beneficial to the farmer. One study used the California mastitis test (CMT) at the 2<sup>nd</sup> or 3<sup>rd</sup> milking after calving to screen quarters; the CMT was read as positive ( $\geq$ trace) or negative (Rosenberg, et al., 2003). Of 184 quarters screened, 63.6% had positive CMT reactions. Positive quarters (n=120) were randomly assigned to receive cephapirin sodium (CefaLak®) for 2 milkings; control quarters were not treated. Microbiological analysis was done at calving, and on days 14 and 28. Of samples obtained at calving, approximately half of the CMT positive quarters were bacteriologically negative; pathogens isolated included: coagulase-negative Staphylococci (28%), environmental Streptococci (7.5%), Gram-negatives (5.0%) and contaminants (6.7%). By day 28, intramammary treatment appeared to increase the proportion of samples that were bacteriologically negative (61% of controls versus 82% of treatment group) and reduce infections with coagulase-negative Staphylococci (23% of controls versus 14% of treatment).

The success of early lactation treatment programs is dependent upon the use of an accurate method to detect infected quarters. On farms, the California mastitis test (CMT) has been the only practical method for diagnosis of subclinical mastitis in quarter milk. A study recently reported the use of CMT to detect subclinical infections in fresh cows (Sargeant, et al., 2001). The CMT was performed on quarter milk samples daily from calving through day 10 post calving and compared to bacteriological results from samples obtained on days 1 and 3 post-calving. The test characteristics of CMT thresholds of trace/1, 2+ and 3 were compared in this study. A CMT threshold of trace on day 3 resulted in the highest sensitivity (66.7% of infected quarters were accurately identified) and specificity (54.8% of uninfected quarters were accurately identified) for detection of major pathogens. Even at the highest sensitivity, approximately 30% of infected quarters would have been missed when CMT was used to select quarters for treatment.

### **Internal and External Teat Sealants**

Both internal and external teat sealants have been suggested as methods to keep environmental bacteria from entering teats during the critical early dry period. There is some research evidence suggesting moderate success in reducing new infections with environmental pathogens using an external polyether-polymethane teat sealant (Timms et al., 1997). A critical factor in successfully using external sealants is proper teat preparation to promote adherence of the sealant. The teat should first be cleaned and treated with an approved dry cow intramammary antibiotic product. Then the teat should be scrubbed with an alcohol pad and allowed to dry. Finally, the sealant should be applied and the cow encouraged to remain standing until the product is thoroughly dry. Even when proper application process is followed, adherence of external sealants rarely exceeds 5 days.

An internal teat sealant that contains a mixture of bismuth subnitrate in a paraffin base (Orbeseal™; Pfizer Animal Health) has been available regionally for many years but has

recently been introduced into a broader market. Orbeseal™ is an inert paste that is infused into the teat at dry off to provide a physical barrier to bacteria. Orbeseal™ remains in the teat throughout the dry period and is removed after the cow has calved. The effectiveness of Orbeseal™ has been reported both with and without the use of intramammary dry cow antibiotics. One study compared the use of Orbeseal™ (n=197 cows) to a control group (n= 204 cows) that received no dry cow therapy (Berry and Hillerton, 2002). Only cows that had SCC of <200,000 cells/ml and no history of clinical mastitis were used in the trial. Orbeseal™ significantly reduced clinical mastitis during the dry period (0% of Orbeseal™ versus 3% of control cows) and reduced the rate of new subclinical infections detected at calving (12% of Orbeseal™ versus 45% of control cows).

In another study, a smaller but statistically significant reduction in new subclinical infections was identified. The use of Orbeseal™ combined with intramammary dry cow therapy (Orbenin-DC, Pfizer Animal Health) was compared to the use of intramammary dry cow therapy alone (Godden et al., 2003). At 1-3 days in milk, there were fewer new mastitis infections (21% of Orbeseal & Orbenin-DC versus 26% of Orbenin-DC alone) and fewer total infections (23% versus 30%) in cows that received both products. In general, the use of Orbeseal™ appears to be an effective method of reducing the development of new mastitis infections. Orbeseal™ does not treat existing infections and most herds should combine the use of Orbeseal™ with dry cow therapy.

### **Conclusion**

The dry period continues to be a high risk period for the development of mastitis infections. Infections acquired during the dry period reduce milk yields and increase the probability that cows will develop clinical mastitis during the subsequent lactation. Udder hygiene scores of dry cows should be monitored so that exposure to environmental mastitis pathogens can be controlled. The use of long acting intramammary antibiotics continues to be fundamental for the production of high quality milk and the ability to select quarters for selective dry cow treatment is limited because of inadequate performance of the CMT or SCC thresholds as screening tests. The combined use of internal teat sealants with dry cow antibiotics may further reduce new infections during the dry period.

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Figure 3. Udder Hygiene Chart – available at <http://www.uwex.edu/milkquality/dairyfarm/pdf/UDDER%20HYGIENE%20CHART.pdf>



1-866-TOP-MILK

### UDDER HYGIENE SCORING CHART

Score udder hygiene on a scale of 1 to 4 using the criteria below.  
Place an X in the appropriate box of the table below the pictures.  
Count the number of marked boxes under each picture.

DATE: 4-15-03  
 FARM: \_\_\_\_\_  
 GROUP: (1) High cows

**SCORE 1**  
Free of dirt

**SCORE 2**  
Slightly dirty  
2 – 10 % OF SURFACE AREA

**SCORE 3**  
Moderately covered with dirt  
10 – 30 % OF SURFACE AREA

**SCORE 4**  
Covered with caked on dirt  
>30% OF SURFACE AREA



<del>1</del>	<del>2</del>	<del>3</del>	<del>4</del>	<del>5</del>	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
<del>6</del>	<del>7</del>	<del>8</del>	<del>9</del>	<del>10</del>	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10
<del>11</del>	<del>12</del>	<del>13</del>	<del>14</del>	<del>15</del>	11	12	13	14	15	11	12	13	14	15	11	12	13	14	15
<del>16</del>	<del>17</del>	<del>18</del>	<del>19</del>	<del>20</del>	16	17	18	19	20	16	17	18	19	20	16	17	18	19	20
<del>21</del>	<del>22</del>	<del>23</del>	<del>24</del>	<del>25</del>	21	22	23	24	25	21	22	23	24	25	21	22	23	24	25

Total Number of udder scores: 59

Number of udders **scored 1**: 30

Number of udders **scored 2**: 7

Number of udders **scored 3**: 10

Number of udders **scored 4**: 12

**Percent of Udders Scored 3 & 4:**  $\frac{22}{59} = 37\%$

Udders scored 3 and 4 have increased risk of mastitis as compared to scores 1 & 2



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