Managing Cows, Milking and the Environment to Minimize Mastitis

Pamela L. Ruegg, DVM, MPVM

Dept. of Dairy Science, University of Wisconsin, 1675 Observatory Dr., Madison WI 53706
Email: plruegg@wisc.edu

Take Home Messages

- Managing mastitis requires consistent measurement of appropriate key performance indicators (KPI)
- KPI for mastitis in cows should include systems for monitoring the occurrence of both clinical and subclinical mastitis
- KPI for milking performance can be used to define the acceptable function of the milking machine and monitor performance of milking technicians
- Hygiene of the cow and housing area are important risk factors that must be monitored to ensure reduced exposure to mastitis pathogens

Introduction

Mastitis is caused by a bacterial infection of the udder and can occur in a subclinical or clinical state. Both states can result in significant reductions in animal wellbeing and dairy farm profitability. Bacteria that cause mastitis are often classified as "contagious" or "environmental" based on their primary reservoir and mode of transmission. The udder of cows that have subclinical infections serves as the primary source of exposure to contagious pathogens and transmission occurs when teats of healthy cows are exposed to bacteria present in milk that came from infected udders. Droplets of infected milk left on milking equipment, milking towels, hands of milking technicians or dripped onto bedding surfaces are common mechanisms for spread of contagious mastitis. Successful control of contagious mastitis pathogens is focused on reducing exposure of teats to pathogens found in milk that originated from infected cows. The term "environmental pathogen" refers to mastitis caused by bacteria found in cow housing areas. Moisture, mud, and manure are common sources of these pathogens. Successful control of environmental pathogens is based on keeping teats healthy, clean and dry.

■ Managing Mastitis in Cows

The old saying "if you don't measure it you can't manage it" is absolutely true of mastitis control programs. Subclinical mastitis is easy to monitor using monthly individual cow somatic cell counts (SCC). However, measuring clinical mastitis is more difficult and requires coordination and trust between milking technicians and animal health managers. A mastitis monitoring program should be designed to answer the following questions: 1) What is the incidence (rate of new cases) of clinical mastitis? 2) What proportion of cases are severity score 3? 3) What are the most common bacteria that are causing clinical mastitis? 4) What are the current treatment protocols? 5) How many days is milk discarded as a result of treatment? 6) How many cases require changes to the original treatment protocol or experience recurrence of the case within the same lactation? 7) What percent of lactating cows are being milked on less than 4 quarters? 8) What percent of cows that experience clinical mastitis are culled in the same lactation or die?

Monitoring Clinical Mastitis

Managers of small herds will generally need to record data on paper and will need to monitor trends of data collected over longer time periods (3-4 month periods). Managers of larger herds can configure computerized dairy management record systems to rapidly create appropriate reports. Data entry systems should have only one mastitis event entered for each case. Key performance indicators (KPI) that are defined at the cow-level (occurrence of mastitis in 1 or more quarters of a cow) rather than the individual quarter are easier to record and may better reflect the important economic consequences of mastitis (Table 1). Goals for KPI are derived from populations of herds and may need to be adjusted for individual herd circumstances.

Table 1. Key performance indicators for clinical mastitis.

Indicator	Calculation[a]	Suggested Goal
Incidence Rate	Sum of first cases occurring in the appropriate time period[a] divided by average number of lactating cows in the same time period[b]	< 25 new cases per 100 cows per year
Proportion of cases scored 3 (severe)	Number of severity score 3 cases divided by the total cases	5-20% of total cases
Proportion of cases that die	Number of cows with mastitis that died divided by total cases	2%
Proportion of cases with treatment changes	Number of cases that have the initial treatment changed or supplemented due to non-response divided by the total cases[c]	<20%
Proportion of cases that are recurrent (≥2nd treatment)	Number of cows with ≥second case of mastitis at >14 days post treatment divided by the total cases	<30%
Proportion of cows with > 1 quarter	Number of cases with 2+ quarters affected divided by the total cases	<20%
Percent of herd milking with <4 quarters	Number of cows milking with < 4 quarters[d] divided by the number of lactating cows	<5%

[a]numerators and denominators in all indices should include the statement "in the appropriate time period."; [b]a more correct denominator would exclude cows that had previously experienced a clinical case within that lactation; [c]cases which are detected but do not receive treatments should be included; [d]cows that are milked with quarter milkers should be included in the numerator.

Monitoring Subclinical Mastitis

The first step in monitoring subclinical mastitis is to ensure that SCC values are routinely obtained from all cows on a regular basis. Generally all cows with SCC values >250,000 cells/ml (linear somatic cell score of approximately 4.0) are considered to have subclinical mastitis. Somatic cell counts should be reviewed at both the herd and cow. Evaluation of monthly SCC patterns for the herd can be helpful for troubleshooting subclinical mastitis problems. For example, herds that exceed targets for prevalence of subclinical mastitis at first test are often herds that are experiencing problems with environmental mastitis pathogens. In these cases, housing conditions, udder hygiene and management of dry and transition cows should be investigated. When contagious mastitis is a problem, prevalence of subclinical mastitis usually increases as lactation progresses and as cows age (because of more opportunities for exposure to infected milk). When contagious mastitis is suspected, transmission of mastitis pathogens during milking should be investigated with special emphasis on detecting inadequate teat dipping or transmission on milking equipment. A large proportion of cows with apparently chronically increased SCC indicates that cows are infected with pathogens that can be transmitted in a contagious manner.

Assessments of subclinical mastitis should begin with the following questions: 1) What percent of lactating cows have subclinical mastitis (defined based on SCC)? 2) What percent of cows developed new infections in the last month (defined based on SCC)? 3) What are the most common bacteria recovered from cows with SCC values >200,000 cells/ml? 4) What percent of subclinical cases last more than 2 months? 5) What percent of cows have subclinical mastitis at the first test and the last test? Data to answer these questions can often be found in summarized reports available from DHIA testing centers or the data can be downloaded and manipulated in customized spreadsheets or dairy management programs. Common KPI for subclinical mastitis are shown in Table 2**.**

Table 2. Calculation of key performance indicators for subclinical mastitis.

Indicator	Calculation	Suggested Goal
Prevalence	Number of cows with SCC >250,000[a] divided by the number of cows with SCC	<15% of the herd
Incidence	Number of cows with SCC > 250,000 for the first time in the time period of interest[b] divided by the number of cows with SCC below the threshold in the previous time period	<5% if incidence is determined based on the first SCC above threshold in the lactation; up to 8% if calculated based on month to month changes in SCC[b]
Prevalence at 1st DHIA Test	Number of cows with SCC >250,000[a] at 1st DHIA test divided by the number of cows with first test SCC	<5% of 1st lactation <10% of lactation 2+
Prevalence at last DHIA Test	Number of cows with SCC ≥250,000[a] at the last test before dry off divided by the number of cows with last test SCC	<30% of cows with last test days before dry off

[a]linear somatic cell score of 4 is used interchangeably with somatic cell count of >250,000 cells/ml; [b]The appropriate time period will vary depending the intended use of this index. Many DHIA centers & computer management programs will calculate this index based on changes between 2 months. Others may calculate it based on the SCC values available in the current lactation.

At the cow-level, it may be useful to review a list of individual cows sorted by SCC to identify cows that may require individual interventions. The use of a rapid cowside quarter-level SCC test, can help farmers make important management decisions such as whether or not to segregate, treat, culture, withhold high SCC quarters or cull the cow.

▪ Managing Exposure to Environmental Pathogens

High quality milk is produced when cows live in a clean and dry environment and are gently milked using practices that favor teat health and minimize exposure to contagious mastitis pathogens. To effectively prevent mastitis, dairy farmers should have monitoring programs that address the following questions: 1) Do cow housing areas provide clean and dry environments for all stages of the lactation cycle? 2) Are the udders clean enough and are teat ends healthy? 3) Is the milking system functioning properly? 4) Are milking technicians using the defined milking routine?

Providing a Clean and Dry Environment

Many opportunities for exposure to mastitis pathogens occur outside of the milking facility and all dairy farm employees should be accountable for implementing mastitis control programs. Several studies have identified relationships between cow cleanliness and measures of milk quality (Barkema, et al., 1998, Reneau et al., 2003, Schreiner and Ruegg, 2003). Cows with dirty udders have been shown to be more likely to have greater SCC and an increased risk of mastitis (Schreiner and Ruegg, 2003). Contact of teats with moisture, mud, and manure usually results in increased rates of clinical mastitis and the farm manager should monitor both teat and udder hygiene using standardized scoring systems (available online: www.milkquality.wisc.edu – click on milking management then evaluation tools). No more than 20% of the herd should be categorized as having “dirty udders” (UHS of 3 or 4) (Schreiner and Ruegg, 2003).

Management of bedding can have a large influence on exposure of teats to mastitis causing bacteria. The amount of moisture and organic matter present in cow bedding are especially important (Hogan et al., 1989; Zdanowicz et al., 2004; Hutton et al., 1990). A linear relationship between the rate of clinical mastitis and the number of Gram-negative bacteria in bedding has been demonstrated (Hogan et al., 1989). Organic bedding materials will support more bacterial growth as compared to inorganic bedding. Sand bedding usually has the least bacterial populations but use of recycled sand can increase moisture content and result in increased growth of mastitis pathogens.

▪ Managing the Milking Process.

A consistent method of pre-milking sanitation and uniform attachment of properly functioning milking machines are both fundamental processes that help ensure production of high quality milk. Appropriate testing of milking equipment requires specialized equipment and should follow procedures that have been defined by the NMC (www.nmconline.org). An appropriately designed milking system will provide stable partial vacuum and effective compression at the teat end to rapidly remove milk without causing congestion. Tests of milking equipment should be performed during milking time as part of scheduled maintenance program, when changes are made to the milking system and whenever farm conditions indicate the need to improve milking performance or mastitis control. Key performance indicators for milking machine function include average claw vacuum and maximum claw vacuum fluctuation (Table 3).

Table 3. Selected KPI for milking systems and milking performance

Source	Indicator	Suggested Goal
Milking Machine	Average claw vacuum	35-42 kPa (10.5-12.5" Hg)
	Average milk flow	2.3 – 4.1 kgs/min
	"D" phase of the pulsation cycle	At least 150-200 ms
Milking Process	Premilking teat dip contact time	30 seconds before dry off[a]
	Milking unit attachment time	3 to 8 minutes (depending on milk production)
	% of teats with at least 75% coverage with post-milking teat dip	>90%

[a]some product characteristics may allow for more rapid bacterial kill, label instructions for products with published research data should be followed.

Milking Management

A number of parlor work routines can be successfully used as long as they meet the principles of good milking practices. Several common routines have been developed that utilize groups of 3-4 cows to ensure that prep-lag times and pre-dip contact time are optimized. When designing a parlor work routine, important principles include providing sufficient contact time for the premilking teat disinfectant to be effective, allow time for removal of foremilk and thorough drying of teats, attaching the milking unit within an interval that maximizes milk letdown, extracting milk before milk flow diminishes and ensuring that post-milking teat disinfectants are properly applied to all teats. Consistent use of good milking practices is essential to control mastitis and regular observation of the milking process should be performed to to evaluate compliance with KPI for milking performance (Table 3).

Five key components of the milking process should be routinely assessed.

- 1) *Premilking teat disinfection*. There is no question that predipping using an effective disinfectant is the most effective method to disinfect teats (Galton et al., 1984; Galton et al., 1986). Pre-dipping using iodine has been demonstrated to reduce standard plate counts and coliform counts in raw milk by 5 and 6 fold, respectively, as compared to other methods of premilking udder preparation (Galton et al., 1986). For effective reduction in bacterial numbers, the disinfectant must be in contact with teat skin for sufficient time to adequately kill bacteria. Teat dips must be properly formulated, stored in clean containers, completely applied to debris free teats, and allowed sufficient time (usually at least 30 seconds) for action before removal.
- 2) *Examination of foremilk*. The examination of milk before attaching milking units is useful to ensure that abnormal milk is diverted from the human food chain and to identify cases of clinical mastitis at an early stage when slightly abnormal milk may be the only symptom. Forestripping is effective when 2-3 streams of milk are removed and is a very effective way to stimulate milk letdown. When both predipping and forestripping are practiced, there is no data that indicates that the order that the steps are performed will affect milk quality (Rodrigues et al., 2005). Milking technicians should be encouraged to wear disposable nitrile or latex gloves to reduce the potential spread of mastitis pathogens by contaminated hands.
- 3) *Drying of Teats*. Effective drying of teats is probably the most important step to ensure hygienic teat preparation. Drying of teats has been demonstrated to reduce bacterial counts of teat ends from 35,000 – 40,000 cfu/ml for teats that were cleaned but not dried to 11,000-14,000 cfu for teats that were dried using a variety of paper towels (Galton et al., 1986). A single dry cloth or paper towel should be used to dry teats of each cow. The use of a single towel to dry udders on more than 1 cow has been associated with a greater monthly rate of clinical mastitis (7.8% for herds that used 1 towel/cow versus 12.3% for herds that used towels on >1 cow; (Rodrigues et al., 2005).
- 4) A*ttaching the milking unit.* One objective of the milking routine is to attach the milking unit to well-stimulated cows that have achieved milk letdown, thus maximizing milk flow. The time period between stimulation

of the cow and unit attachment is often referred to as the "prep-lag" time. It is well recognized that the need for stimulation varies depending on yield, stage of lactation, milking interval and breed (Bruckmaier, 2005). Historically, a prep-lag time of 45-90 seconds has been recommended, but negative consequences (reduced milk yield) have not been reported until lag times have exceeded 3 minutes (Dzidic et al., 2004; Rasmussen et al., 1992). The failure to achieve adequate milk letdown may result in bi-modal milk flow and the application of the milking unit without stimulation or immediately after stimulation should be discouraged. It appears that prep-lag times longer than 90 seconds will not be uniformly detrimental but premature attachment of the milking unit should be avoided (Dzidic et al., 2004).

- 5) *Managing cows post-milking*. Post-milking teat disinfection was developed to reduce the transmission of contagious mastitis pathogens and is based on killing bacteria that are present in milk found on teat skin after milking has been completed. Post-milking teat dipping is one of the most highly adopted practices in the dairy industry and it is the final hygienic defense against infection after milking is completed. While teat dipping is universally recognized as a useful practice, effective implementation of teat dipping is often variable. Evaluation of the effectiveness of post-milking teat dipping is best performed when milking technicians are not aware of the evaluation. When colored teat dips are used, one effective method of evaluation is to surreptitiously score teats of cows in the return lanes after milking. If possible teats from at least 20-30 cows should be examined and the goal is to observe complete coverage (75%) of at least 95% of observed teats. Digital photographs of well covered and inadequately covered teats are an excellent training tool that can be used to demonstrate proper teat dipping.

Conclusion

Many farmers have adopted management practices that have resulted in reduced prevalence of contagious mastitis pathogens. However, on many farms, changes in housing and management strategies have resulted in increased exposure to environmental mastitis pathogens. Continued progress in controlling environmental mastitis is based on developing and implementing effective monitoring and control strategies that are specific to each farm. Each farmer should identify and routinely monitor KPI that allow for surveillance of the incidence of clinical and subclinical mastitis in cows, oversight of milking machine function and milking performance and identification of important environmental risk factors such as hygiene and teat end health.

References

Barkema, H. W., Y. H. Schukken, T. J. G. M. Lam, M. L. Beoboer, G. Benedictus, and A. Brand. 1998. Management practices associated with low, medium and high somatic cell counts in bulk milk. J. Dairy Sci. 81:1917-1927.

Bruckmaier, R. M. 2005. Normal and disturbed milk ejection in dairy cows. Domestic Anim. Endocrinol. 29:268-273.

Dzidic, A., J. Macuhova, and R. M. Bruckmaier. 2004. Effects of cleaning duration and water temperature on oxytocin release and milk removal in an automatic milking system. J. Dairy Sci. 87: 4163-4169.

Galton, D. M., L. G. Petersson, W. G. Merrill, D. K. Bandler, and D. E. Shuster. 1984. Effects of premilking udder preparation on bacterial population, sediment, and iodine residue in milk. J. Dairy Sci. 67:2580-2589.

Galton, D. M., L. G. Petersson, and W. G. Merrill. 1986. Effects of premilking udder preparation practices on bacterial counts in milk and on teats. J. Dairy Sci. 69:260-266.

Hogan J. S., K. L. Smith, K. H. Hoblet, D. A. Todhunter, P. S. Schoenberger, W. D. Hueston, D. E. Pritchard, G. L. Bowman, L. E. Heider, B. L. Brockett, and H. R. Conrad. 1989. Bacterial counts in bedding materials used on nine commercial dairies. J. Dairy Sci. 72:250-258.

Hutton, C.T., L. K. Fox, and D. D. Hancock. 1990. Mastitis control practices: differences between herds with high and low milk somatic cell counts. J. Dairy Sci. 73:1135-1143.

Rasmussen, M. D., E. S. Frimer, D. M. Galton, and L. G. Petersson. 1992. The influence of premilking teat preparation and attachment delay on milk yield and milking performance. J. Dairy Sci. 75:2131-2141.

Reneau, J. K., A. J. Saylor, B. J. Heinz, R. F. Bye and R. J. Farnsworth. 2003. Relationship of cow hygiene scores and SCC. Proc. 42nd Ann. Conf. Natl. Mastitis Counc. 42:362-363.

Rodrigues, A.C.O., D. Z. Caraviello, and P. L. Ruegg. 2005a. Management of Wisconsin Dairy herds enrolled in Milk Quality Teams. J. Dairy Sci. 88:2660-2671.

Schreiner, D. A. and P. L. Ruegg. 2003. Relationship between udder and leg hygiene scores and subclinical mastitis. J. Dairy Sci. 86:3460-3465.

Zdanowicz, M., J. A. Shelford, C. B. Tucker, D. M. Weary, and M. A. G. von Keyserlingk. 2004. Bacterial populations on teat ends of dairy cows housed in free stalls and bedded with either sand or sawdust. J. Dairy Sci. 87:1694-1701.