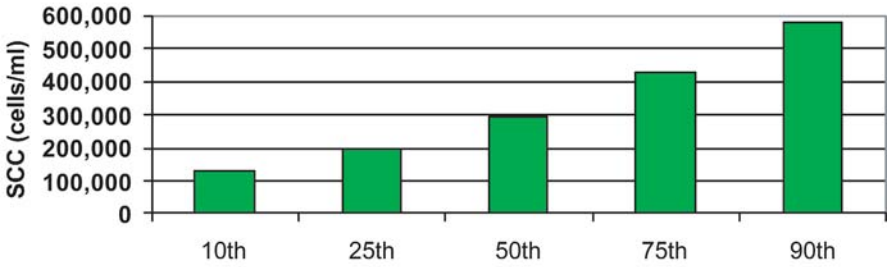
10 Smart Things Dairy Farms Do To Achieve Milking Excellence

Pamela Ruegg, DVM, MPVM
University of Wisconsin – Madison

1. SMART FARMS SET PERFORMANCE GOALS

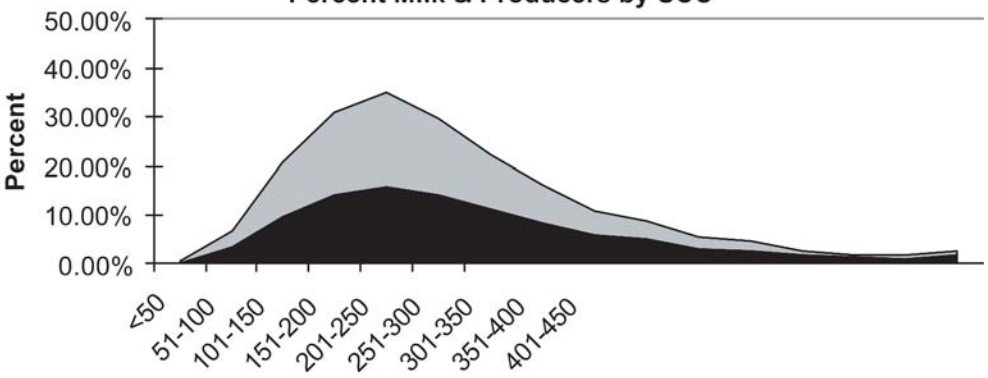
There is an old saying that you can't get to your destination unless you know where you are going. Many farms that start on the path to milking excellence don't make it because they don't have clear quality goals for their farms. Many dairy farms consistently produce high quality milk. In 1998, over 1,800 Wisconsin dairy farms had average bulk tank somatic cell counts (BTSCC) of <120,000 cells/ml and over 4,500 dairy farms obtained average BTSCC of <200,000. In fact, Wisconsin grade A dairy farmers with BTSCC >400,000 cells/ml were ranked in the bottom 25% of herds (Fig. 1).[1]

Figure 1. 1998 BTSCC Percentiles all WI Grade A Herds



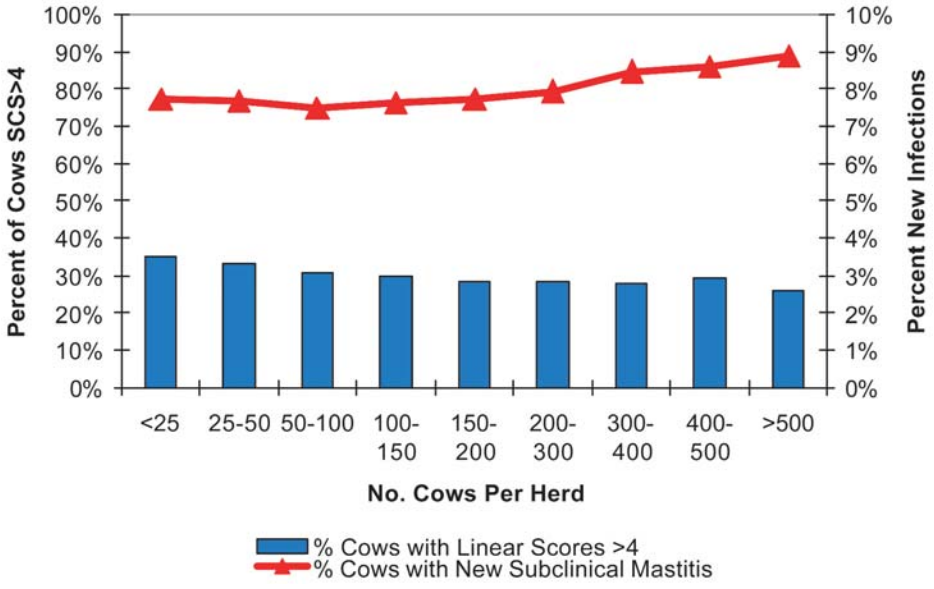
Herd size does influence somatic cell count but not in the manner that many expect. As a group, larger more specialized dairy producers tend to be more focused on quality than more diversified dairy operations. In the December 1998 Chicago regional market order data, 16% of producers and 50% of milk had SCC <250,000 cells/ml; 84% of the milk was produced with a BTSCC of <400,000 (Fig. 2) cells/ml.

Figure 2. 1998 Chicago Regional Market Data
Percent Milk & Producers by SCC



Achievable product quality goals should be set for milk leaving the dairy. The most obvious goal should be to achieve ZERO antibiotic residues. Standard plate counts should average <10,000 cfu. Goals for BTSCC should be set for each farm based upon current farm status but the ultimate objective should be to consistently ship milk with a BTSCC <250,000 cells/ml. BTSCC generally reflects the prevalence of subclinical mastitis that a dairy herd is experiencing. All cows with SCC >250,000 are considered to have subclinical mastitis. The prevalence of subclinical mastitis (the percentage of cows with SCC >250,000) can only be determined by obtaining individual cow SCC values or by performing the CMT on each cow. The prevalence of subclinical mastitis is dependent upon just 2 factors: the new infection rate (percentage of cows developing new subclinical infections) and the duration of each subclinical infection. Mastitis caused by environmental pathogens (coliforms, and environmental streptococci) is generally of shorter duration than mastitis caused by contagious pathogens (*Staph. aureus*, *Strep. ag* and *Mycoplasma bovis*). Herds experiencing problems with environmental mastitis can often rapidly influence the BTSCC by reducing the rate of new infections. Culling is a common strategy for reducing the duration of infection. Many mastitis control programs for contagious mastitis are focused too heavily on culling rather than controlling new infections. Common industry goals for subclinical mastitis are: 85% cows with linear somatic cell scores <5 and new subclinical infection rate <5% per month. [2] These goals are probably aggressive as evidenced by the performance of Wisconsin DHIA herds in June 2000 (Fig. 3). There were >7000 herds included in the data and no size category had <40 herds contributing. The prevalence of subclinical mastitis in the top 10% (based on milk quality) of these herds was <5%.

Figure 3. AgSource Herd Summary Data by Herd Size
June 2000



2. SMART FARMS RAPIDLY IDENTIFY PROBLEMS

Farms that consistently produce high quality milk have methods to monitor herd performance. As farms grow, the farm owner usually becomes the manager of the milking process rather than the actual person milking the cows. Many farms have multiple people milking cows and in the absence of a clearly defined monitoring system, it is easy for milking system managers to lose control of the milking process. The rate of clinical mastitis is often unknown to milking process managers. Specialized milking personnel on larger dairies may have an incentive not to detect or report all cases. Milking technique may influence the perception of clinical mastitis on a farm. Only severe cases of clinical mastitis are detected with milking routines that do not include forestripping. In this instance the only clue that abnormal milk is going into the bulk tank may be highly variable BTSCC values. Unless SCC records are routinely reviewed, even this indicator can be missed. Only 65% of dairy farmers that participated in a WI pilot program emphasizing milk quality teams reported that they routinely reviewed SCC records on a monthly basis.[3] Only 58% of these WI farmers reported recording clinical cases of mastitis. In another survey, less than half of Wisconsin dairy farmers reported that all cows that received antibiotic treatments had a written treatment record.[4]

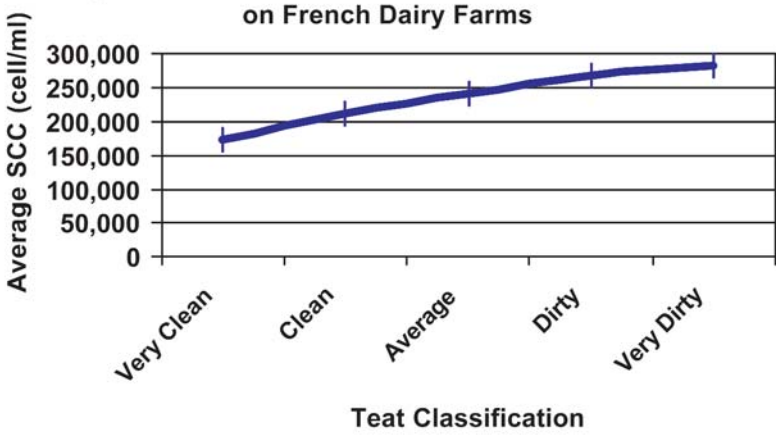
Variability due to differences in detection and definition of clinical mastitis contributes to large differences reported in clinical mastitis rates among studies. One summary reported that 7 to 64% of all lactations experienced clinical mastitis.[5] A summary of 11 studies reported a monthly weighted average incidence of 3.2% and an annual weighted incidence of 38%.[6] A recent study of dairy herds in the UK with BTSCC averages<100,000 cells/ml reported that the average proportion of the herd affected was 23.1%.[7] Goals for clinical mastitis should be based upon individual farm conditions but a reasonable goal for the incidence of clinical mastitis on commercial dairy farms is 2% new cases per month (24% per year). Unrecognized culling can mask mastitis problems and allow serious herd problems to develop prior to detection. According to the NAHMS Dairy '96 study, the top 2 culling reasons reported by dairy farmers in 1995 were reproduction (26.7% of culls) and mastitis (26.5%).[8] This survey also reported that mastitis was the 3rd leading cause of adult cow mortality, accounting for 16.3% of all adult cow deaths.

3. SMART FARMS MILK CLEAN COWS

Many progressive dairy farms have controlled contagious mastitis. On these farms, the major source of mastitis is often environmental pathogens such as E.coli and the environmental streptococci.[9] Cows are exposed to environmental mastitis infections between milkings in their stalls or housing areas. Organic bedding sources, wet or muddy fresh pens, and infrequently or inadequately bedded mattresses are often the environmental niches for these pathogens.

Sand is an excellent inorganic bedding source and has some characteristics (such as getting kicked out of the stall) that help to reduce exposure of the udder to environmental bacteria. Even sand can be mishandled and sand stalls should be groomed on a daily basis. Cow walkways are also a source of exposure to manure and should be frequently scraped. Cows that enter parlors dirty take longer to milk and reduce parlor throughput. A French study demonstrated that teat cleanliness is a good predictor of herd average somatic cell count (Fig. 4).[10] Sending dirty cows to the milking parlor unfairly penalizes milking personnel by requiring them to spend more time prepping cows prior to unit attachment. Predipping is an effective way to reduce exposure to environmental bacteria. Effective predipping consists of adequate coverage of the teat by use of non-recycling teat dipper. Milking routines must be designed to allow for a minimum predip contact time of 20-30 seconds. Iodine based teat dips (0.5%) continue to be effective on most farms. Teat foamers are showing promise as an effective method of premilking teat sanitation. Individual paper or cloth towels should be used to thoroughly dry teats prior to unit attachment.

Figure 4. Teat Cleanliness and Somatic Cell Count on French Dairy Farms



4. SMART FARMS STANDARDIZE THEIR MILKING ROUTINES

Achieving a consistent milking routine is the key to quality milk and is a goal of most farmers. However, many farms have not explicitly described the milking process for their personnel. Less than 20% of WI farms participating in milk quality teams had written milking routines prior to beginning the project.[3] There is tremendous variability in milking routine reported by farmers. In a non-random survey of 338 WI dairy producers conducted in 1998, four routines accounted for 63% of all routines used (Table 1) but the remaining 117 herds reported using an additional 23 milking routines.

Table 1. Reported Pre-Milking Procedures of selected WI Dairy Farmers in 1998

Pre-Milking Steps	Number of Farms Reporting	Percent of Total[a]
Predip, Dry, Attach	69	21.9%
Forestrip, Predip, Dry, Attach	60	19.0%
Predip, Forestrip, Dry, Attach	40	12.7%
Predip, Dry, Forestrip, Attach	29	9.2%

[a]315 farms reported enough data to characterize their milking routine

It is not unusual for consultants that are observing parlor performance to discover that milkers on the same farm are using different milking routines. The key to optimizing milking performance is to milk clean and dry udders, coordinate unit attachment with milk letdown, remove milk rapidly and remove the unit when milking is completed. Milking units should be attached within 40-90 seconds from the beginning of teat stimulation and cows should not be surprised by unexpected procedures occurring during the preparation process. Milking routines should be written down, posted in the milking area and translated for non-english speaking personnel. Parlor processes should be designed to accommodate the working routine of the personnel. The choice of a territorial (each milker manages all steps of the milking process for part of the parlor) versus sequential (milkers work as a team, each milker performing part of the milking process) should be made based in part upon the compatibility and communication abilities of parlor personnel. Sequential work routines are rarely effective when milking personnel work at different rates, speak different languages, or are unclear about farm standards of performance.

5. SMART FARMS TRAIN THEIR STAFF

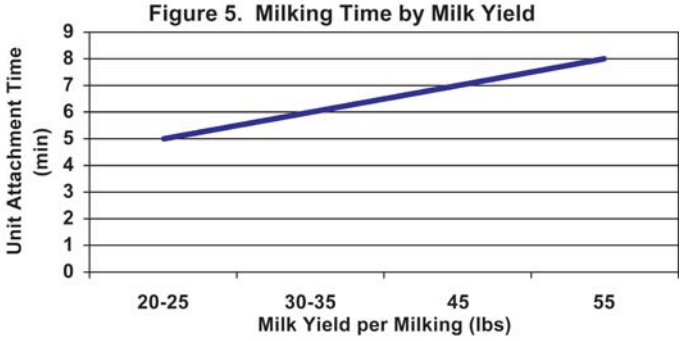
Today's dairy managers increasingly rely upon others to milk their cows. In 1998, there were an average of 6 different people milking cows per month per farm on Wisconsin dairy farms that responded to the milking procedures survey. At the beginning of the WI milk quality team pilot project, more than 40% of respondents indicated that they NEVER trained milkers and an additional 38% responded that they trained milkers only when hired. Only 15% of Spanish speaking milking personnel, attending a worker training session in Wisconsin in April 2000, indicated that they had worked on their current farm for >1 year and 16% had received NO training regarding milking procedures. The most common training mentioned was "on the job experience with a supervisor" (50%). The image and concern about quality that a farm projects to employees will either motivate or demotivate employees in their daily milking practices. Motivation and job satisfaction of employees is generally based more upon the perceived value of their effort rather than pay schedules. On an increasing number of farms, the production of quality milk depends upon continuous effort by non-family employees. Investing and improving employees is a smart management strategy that will return rewards in both better job performance and enhanced employee retention.

6. SMART FARMS MAINTAIN & UPDATE THEIR MILKING SYSTEMS

A properly functioning milking system is essential for the production of high quality milk. Milking equipment represents a substantial portion of farm capital investment and the system needs to be regularly evaluated and updated. Thirty-five percent of quality team participants had never had their milking systems analyzed during milking prior to beginning the project. Milking systems should be adjusted to provide claw vacuum of 10.5-12.5" Hg during peak milk flow.

The use of a flow simulator set at 1.5 gal/minute flow rate is an excellent method to determine vacuum level at peak flow. Low claw vacuums result in longer milking times, overmilking and teat end damage. Milk yield is directly related to unit attachment time (Fig. 5).[12]

Figure 5. Milking Time by Milk Yield



7. SMART FARMS HAVE TREATMENT PROTOCOLS

Treatment protocols are used to define standard treatments for common diseases on dairy farms. Treatment protocols are advocated when multiple people have responsibility for administering antibiotic treatments to dairy cattle or when extralabel drug use is prescribed. Extralabel drug use is any use of drugs that is not specifically mentioned on the product label. Examples of extralabel drug use include: 3 tubes of an intramammary tube when the product label prescribes 2 tubes; use of intramammary tubes at 8 hour intervals when the product label prescribes 24 hour intervals; use of Excenel® IM for any indication besides bovine respiratory disease or footrot; or dosage of 40 cc penicillin SQ when the label dosage is 13 cc SQ. A requirement for legal extralabel drug use in food animals is the existence of a valid veterinarian/client/patient relationship (VCPR). A key requirement of the VCPR is that "the veterinarian has assumed the responsibility of making medical judgments regarding the health of the animals and the need for medical treatment and the client (owner or caretaker) has agreed to follow the instructions of the veterinarian." Documentation (such as clinical mastitis records) of extralabel drug usage is required. Treatment protocols provide a mechanism for increased communication about treatment plans between the veterinarian and client and allow the farm to partially fulfill requirements for legal extralabel drug use. The use of treatment protocols is highly associated with adoption of clinical mastitis records and longer milk discard times. Farms participating in the WI quality teams that had treatment protocols were 6.5 times more likely to maintain clinical mastitis records and discarded milk for one-half day longer. Treatment protocols can be simple (Table 2) but should be defined by consultation between the local veterinarian, farm owner and key animal caretakers.

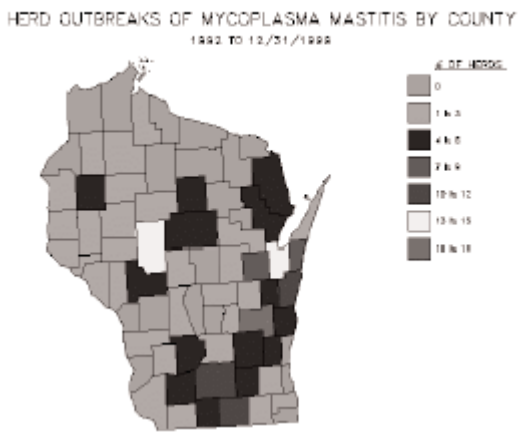
Table 2. Example of Treatment Protocol for Clinical Mastitis

Clinical Signs			
Abnormal milk only	Give oxytocin, put leg band on	Use ¼ milker for 2 milkings	Recheck, remove band if normal, take sterile culture if not normal
Abnormal milk PLUS swollen udder	Give oxytocin, put leg band on	Freeze sterile milk sample; give 1 intramammary tube after each milking for 2 RX, Put in Sick Pen	
Abnormal milk PLUS swollen udder or PLUS temp>103, off feed, down in milk	Give oxytocin, put leg band on	Freeze sterile milk sample; give 1 intramammary tube after each milking for 2 RX, 2 aspirin, Put in Sick Pen	Recheck 2 hours later, give 3 l hypertonic saline if temp >103.5, CALL VET if not improved 2 hours after saline
Down & Dehydrated	→		CALL VET

8. SMART FARMS HAVE MASTITIS BIOSECURITY PLANS

Biosecurity is a very trendy topic of discussion in dairy magazines. Mastitis biosecurity refers to keeping cattle safe from contagious mastitis pathogens such as *Staphylococcus aureus*, *Streptococcus agalactia* and *Mycoplasma bovis*. While *Staph aureus* and *Strep ag* are well known threats to milk quality, mastitis caused by *Mycoplasma bovis* has more recently been recognized in Midwestern and Eastern states. Prior to 1992, there were only 2 confirmed herd outbreaks within Wisconsin, between 1992 and 1998 at least 140 herd outbreaks of that organism were reported.[13] Herd outbreaks of Mycoplasma mastitis have been isolated from most Wisconsin counties that have substantial dairy cow populations (Fig 6).

Figure 6. Herd Outbreaks Diagnosed at the WI Animal Health Lab



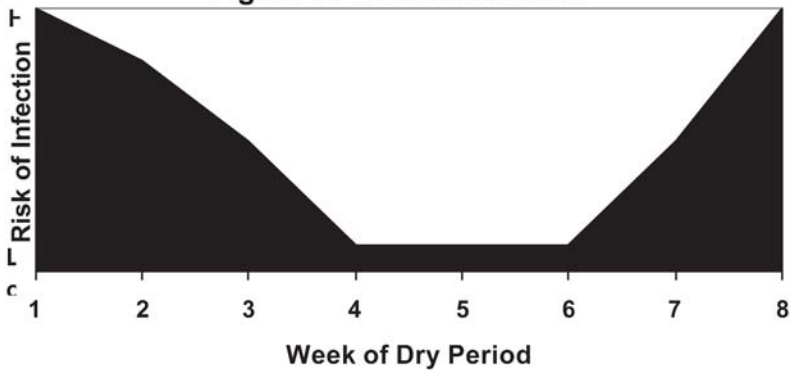
Mycoplasma mastitis is a contagious mastitis pathogen that is not easily treated in dairy cattle. It can cause both clinical and subclinical mastitis and must be diagnosed by culture of bulk tank or cow samples on specially requested media. Once diagnosed in a herd, the most common recommendation is to identify infected cattle and cull them. The recent purchase of cattle is a common risk factor for Mycoplasma mastitis infections. In spite of media interest in biosecurity, relatively few farmers have adopted biosecurity practices. In the NAHMS Dairy '96 study, 18% of milking cows were purchased, 45% of herds introduced at least 1 cow, 20% of dairy operations bought lactating cows and 9% bought bulls. In spite of all this cow movement, only 6% of herds isolated introduced cattle, 67% of herds required no testing, 70% of herds did not ask about cow SCC and >90% of herds did not require a milk culture. Biosecurity programs are simply risk reduction programs and consist of appropriate testing, purchase of lower risk animals and controlling access to animals and equipment. A sound mastitis biosecurity program consists of the following steps:

Four Steps

- Buy healthy cattle – younger, non-lactating animals have likely had less exposure to mastitis pathogens and are usually lower risk. Mature, comingled lactating cattle are maximum risk.
- Buy from a healthy herd – The herd SCC should be <250,000 cells/ml; the cow SCC should be <200,000 cells/ml If SCC are not available cows should be CMT negative. Pooled 5 day bulk tank cultures should be free of contagious mastitis pathogens.
- Keep purchased cattle healthy – house purchased cows separately until proven non-infectious to existing herd. Purchased cattle that calve for the first time should be screened with CMT on day 5 post-freshening and all positive quarters cultured.
- Culture bulk tanks twice monthly during periods when cattle are entering the herd and be sure to request Mycoplasma cultures.

9. SMART FARMS TAKE CARE OF THEIR DRY COWS

Figure 7. Risk Of Mastitis



The dry period is a critical time for the development of mastitis (Fig. 7). Dry cows are at risk for mastitis for a number of reasons. During the dry period important preventive practices such as forestripping, predipping and postdipping are discontinued. The teat canal gets shorter, decreasing the physical barrier that external pathogens must travel to infect the gland. As calving approaches the cows immune system becomes depressed, reducing the ability of the gland to fight off new infections. While the importance of dry cow therapy for the control of contagious mastitis is well documented, recent research has demonstrated that infections with environmental

pathogens are often acquired during this period. One study demonstrated that 65% of clinical cases of environmental mastitis had previous isolations of the same pathogen during the dry period that preceded the lactation when the mastitis occurred. Cows that had environmental pathogens isolated at dry off were 4.5 times more likely to have a new clinical case of mastitis during the next lactation.[14] Housing of dry cows is often neglected, especially during an expansion phase when the emphasis is on filling the barn with income-generating lactating cows. As a result, grouping strategies for dry, close-up and fresh cows often put vulnerable, recently fresh animals in close proximity to sick animals. Sick cows were occasionally (39%) or frequently (16%) housed with fresh cows in the majority of farms that responded to the NAHMS Dairy '96 study.[8] Producers that are focused on milking excellence provide a spacious, clean and dry environment for non-lactating cows. They isolate sick cows from fresh cows and ensure that nutritional programs supply adequate vitamin E (1000 IU/day) and selenium levels. Additional practices, such as treatment of all quarters with approved intramammary dry cow therapy, the use of teat sealants (must be applied properly to ensure adequate adhesion days), the use of J-5 vaccines, and fresh cow protocols to screen for contagious mastitis (CMT followed by culture of positive quarters) can be used to achieve the production of high quality milk.

10. SMART FARMS USE APPROPRIATE CONSULTANTS

Dairy farming is a complex process that involves interactions between animals, nature and people. Like other research-based businesses, the growth in knowledge about dairy management practices is extraordinary. Dairy farmers acquire information about animal health from a variety of sources including veterinarians, nutritionists, other producers, dairy magazines and consultants.[8] The use of consultants can help farmers sort through complex issues and make informed decisions. Consultants visit multiple farms, see results from wide variety of management decisions and bring an outside perspective to farm decisions. An increasing use of consultants is the formation of on-farm management teams. On-farm management teams can be formed to troubleshoot specific farm issues or to meet periodically and review farm performance. A properly formed management team can aid the farmer by bringing expertise on narrow issues. Management teams also allow for dialogue between consultants (such as veterinarians and dairy plant personnel) that have shared interest in specific outcomes. The management team format appears to show promise for milk quality issues. Farms that were successful in forming management teams in a Wisconsin milk quality pilot project decreased their BTSCC by 44,972 cells/ml (in a 4 month period) as compared to an increase of 41,063 cells/ml in herds where farms met separately with their consultants.

REFERENCES

1. Ruegg PL & Tabone TJ. The relationship between antibiotic residues violations and somatic cell counts in Wisconsin dairy herds. 2000 J Dairy Sci. 83:2805-2809.

2. Wallace RL. Detecting herd mastitis problems by computer. 2000. Pp 68-78 in Proc. 39th Ann. Mtg. Natl. Mastitis Council, Atlanta GA. Natl. Mastitis Counc., Inc., Madison, WI.

3. Ruegg, PL. Milk quality premiums received by Wisconsin dairy farmers participating in directed milk quality programs. 2000. (abst)562 in Proceedings of the 9th Symp. Intl. Soc. Vet Epi and Econ. Aug. 6-11, Breckenridge, CO.

4. Wilson, D. J., P. M. Sears, and L. J. Hutchinson. 1998. Dairy producer attitudes and farm practices used to reduce the likelihood of antibiotic residues in milk and dairy Beef: A five state survey. Large Anim. Pract. 19:24-30.

5. Fetrow, J. Mastitis: an economic consideration. 2000. pp 3-47 in Proceedings of the 29th annual meeting of Natl. Mast. Coun., Atlanta, GA, Natl Mast Coun. Madison, WI.

6. Reneau, JK. Clinical mastitis records in production medicine programs. 1993. Comp Cont Educ Pract Vet. 15:497-503

7. Peeler, EJ, Green MJ, Fitzpatrick JL, et al. A prospective study of clinical mastitis in low somatic cell count UK dairy herds. 2000(abst) 362 in Proceedings of the 9th Symp. Intl. Soc. Vet Epi and Econ. Aug. 6-11, Breckenridge, CO.

8. Anonymous. Part 1: Reference of 1996 dairy management practices. 1996. available on line: www.aphis.usda.gov/vs/ceah/cahm

9. Sargeant, J. M., H. M. Scott, K. E. Leslie, M. J. Ireland, and A. Bashirl. 1998. Clinical mastitis in dairy cattle in Ontario: frequency of occurrence and bacteriological isolates. Can Vet J, 39:33-38.

10. Doumalin, L. 1995. 1995 Variation des taux cellulaires. Le batiment, premier responsible. Production Latiere Moderne, fev. Rennes, France

11. Ruegg, PL, Rasmussen, MD, Reinemann DJ. 1999. Seven habits of highly successful milking routines. Hoards Dairyman. Aug 10, 1999, pp 529.

12. Mein, GA & Reid DA. 1996. Milking-time test and guidelines for milking units. Pp 235 in Proc. 35th Ann. Mtg. Natl. Mastitis Council, Nashville, TN. Natl. Mastitis Counc., Inc., Madison, WI.

13. Thomas C.B., 1998. Bovine mycoplasmas: A practitioners orientation to host and agent interactions. pp 255 in Proceedings of WI Vet Med Assoc, 84th Ann. Conf. WI Vet Med Assoc, Madison WI

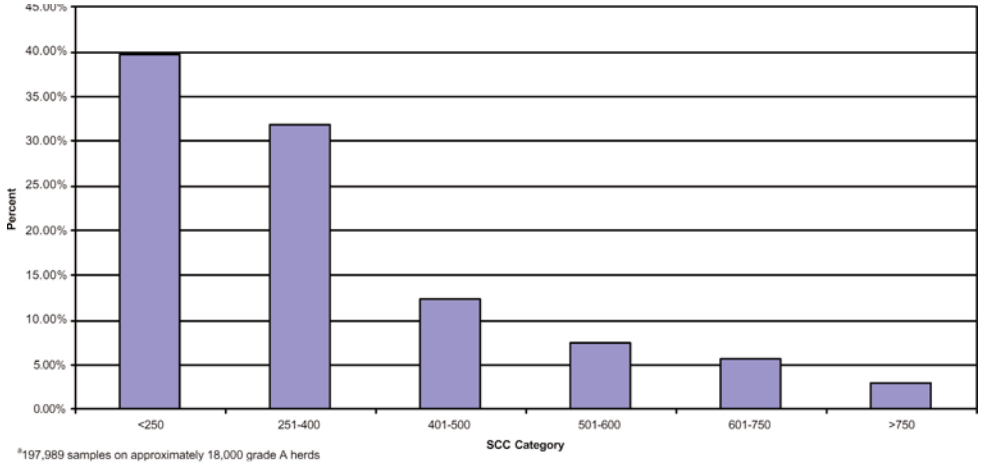
14. Bradley AJ, Green MJ. 1999. The potential impact of the dry period on environmental mastitis – a preliminary assessment of the UK field situation. Pp 106-114 in Proc. 38th Ann. Mtg. Natl. Mastitis Council, Arlington VA. Natl. Mastitis Counc., Inc., Madison, WI.

The Seven Habits of Highly Successful Milking Routines

Pamela Ruegg, Morten Dam Rasmussen,
and Doug Reinemann

The efficient production and harvest of high quality milk is the goal of most dairy farmers. High quality milk consists of milk that is visually appealing, free of adulteration and meets specific quality standards for somatic cell count (SCC), and bacteria. The highest quality milk usually has a SCC of less than 200,000/ml. Many Wisconsin dairy farms are producing high quality milk. In 1998, approximately 40% of Wisconsin grade A dairy producers had an average SCC of <250,000 for the year (Figure 1).

Figure 1: Average Somatic Cell Counts for Grade A Wisconsin Dairy Herds Jan-Nov. 1998*



*197,989 samples on approximately 18,000 grade A herds

Producers of high quality milk know that a consistent method of premilking udder hygiene and the uniform attachment of properly functioning milking machines are important. The objective of milking management is to ensure that teatcups are applied to visibly clean, well stimulated teats, milk is rapidly and efficiently harvested and milking units are removed when milking is completed. A number of milking routines are used on dairy farms. A recent survey of 278 Wisconsin dairy producers identified 28 different pre-milking routines that Wisconsin dairy producers are using (Appendix 1). The "one size fits all" approach doesn't apply to milking routines, but there are seven principles of highly successful cowpreps that contribute to the production of high quality milk.

1. Cows are Calm and Clean before Milking.

Cow cleanliness is a major determinant of both milking efficiency and the rate of intramammary infection. It is estimated that cows that enter parlors dirty, double cow prep time and reduce parlor throughput. A French study demonstrated that teat cleanliness is a good predictor of herd average somatic cell count (Table 1).[2]

Table 1: The Relationship between teat cleanliness and somatic cell count in French dairy farms

Cleanliness of Teats	Number of Farms	Average Somatic Cell Count
Very Clean	141	173,000
Clean	524	211,000
Average	299	241,000
Dirty	64	268,000
Very Dirty	13	281,000

Environmental pathogens are often the major source of mastitis in herds that have controlled contagious mastitis pathogens.[3] Environmental bacteria (such as *E.coli* and the environmental *streptococci*) are often present in organic bedding sources and wet, muddy pens. Management practices that reduce teat end exposure to these organisms will reduce the risk of developing mastitis. Bedding sources that are clean, dry and comfortable will minimize pathogen growth. Inorganic bedding such as sand is often the best choice for reducing pathogen numbers. It is important to recognize that all sand is not created equal and sand must be groomed daily. When rubber filled mattresses are used for cushioning stalls, it is important to adequately bed the stalls to ensure that they remain dry. Further improvements in cow cleanliness can be made through removal of udder hair. It is a good practice to routinely remove udder hair twice yearly.

Cow handling is an important determinant of milking time efficiency. The release of adrenaline within 30 minutes of milking can interfere with milk letdown and prolong unit on-time. Calm cows enter the milking parlor readily and do not generally defecate in the milking parlor. If a number of cows are refusing to enter the parlor or are defecating frequently in the milking parlor, operator and parlor performance should be examined.

2. Cows are Grouped

There are at least two non-nutritional reasons to group cows. Minimizing exposure to cows known to be infected with subclinical mastitis is necessary to control the new infections rate. In herds that have not fully controlled contagious mastitis pathogens, there are generally three classes of cows: 1) non-infected, 2) infected, and 3) unknown infection status. Individual cow SCC values and cow culture results can be used to determine which cows are infected. It is safe to assume that cows with several linear scores of >4 (SCC>250,000) are chronically infected. Most cows that consistently have linear scores <4 are uninfected. Cows

that have a single elevated score, or fluctuating scores fall into the unknown category. Fresh heifers are generally put in the uninfected group until their first SCC is obtained. Fresh mature cows, should be classified based upon their previous SCC status or cultures obtained at calving. In freestall-parlor operations, uninfected cows should be grouped together and milked first. Cows of unknown infection status are milked next and the infected cows are milked last. In stall-barns, infection status can be used to order the cows within the barn so that infected cows are always milked last. Alternatively, one or more milking units can be identified and always used on infected cows. For example, if 6 units are used and 30% of the herd is known to be infected, 2 units could be reserved for use in infected cows and 4 units used for uninfected cows. Sometimes it is necessary to manually sanitize units between cows. To achieve adequate pathogen reduction, units should be rinsed, exposed to 25-50ppm iodine for at least 30 seconds, rinsed and then allowed to dry.

In parlor operations, cow grouping is an important element of parlor performance. Milk yield has a major influence on the length of milking (Table 2).[4]

Table 2: Milking Time and per milking Milk Yield

Milk Yield (lbs)	20-25	30-35	45	55
Time On (minutes)	5	6	7	8

Gains in parlor performance have been documented by various grouping strategies. Sorting cows into low (≤60lbs/cow/day) and high (>60 lbs/cow/day) milk production or fast (<10 min/cow) and slow (>10 min/cow) milking times can have a large influence on parlor throughput. (Table 3).[5]

Table 3: Gains in parallel parlor performance from no grouping compared to grouping strategies.

	Double 8		Double 16	
Grouping	Cows per hour	Milk per Hour	Cows per hour	Milk per Hour
None	------	------	------	------
Group by Milk yield	+1.1 cows/hour	+64 lb/hour	+3.7 cows/hour	+132 lb/hour
Group by Milking Time	+4.0 cows/hour	+68 lb/hour	+5.6 cows/hour	+220 lb/hour

3. A Consistent Premilking Cow Prep is Used

Cows love routine and will reward operators that provide it. Research has documented a 5.5 % increase in lactational milk yield when a standardized milking routine was used compared to a variable milking routine. Achieving consistency can become a challenge when a number of different people are milking cows on an individual dairy each month. Wisconsin parlor operators reported that an average of 5.7 people milked each month as compared to 2.7 milkers reported by stall barn operators. In addition, 70% of the milkers in parlor operations were non-family members as compared to 22% non-family milkers in the stall barn operations. With so many different people milking cows, explicit milking routine instruction and training are a necessary component of quality milk production.

Premilking preparation is a balance between speed (efficiency) and completion of the required steps to clean udders and stimulate milk let down. Milk is stored primarily in the secretory tissue of the udder (the alveoli) and the efficient removal of milk is hastened by coordinating unit attachment with milk letdown. Milk letdown is a combination of both oxytocin (from the pituitary gland) and stimuli from the local nervous system providing feedback to the muscles surrounding the alveoli to release the milk into the ductal and cisternal system for harvest. Selection for high yield and the need for increased cow throughput in parlor operations has led to debate about the necessity of manual stimulation prior to unit attachment.

A summary of six studies that compared no stimulation (unit attachment only) to optimal stimulation (at least 20 seconds manual stimulation and unit attachment within 60 seconds) demonstrates the advantage of manual stimulation (Table 4).

Table 4: Summary of six studies on the effect of stimulation on milking.

	No Stimulation	Optimal Stimulation
Milk Yield (lb/milking)	22.9	23.8
Milk Flow Rate (lb/min)	3.9	4.7
Machine on Time	6.3	5.5

In most situations, **10-20 seconds of manual stimulation is adequate.**

Another controversial issue is the practice of forestripping. Forestripping is advocated as a method to encourage milk letdown, eliminate microorganisms in cisternal milk and to allow the detection of clinical mastitis. Some milkers resist forestripping because it is labor intensive. Studies have shown that forestripping does not improve milking efficiency if the premilking cow prep is greater than 20 seconds. In Wisconsin, forestripping is performed more frequently by operators that have parlors (67% forestrip) or flatbarn/walkthrough parlors (92% forestrip) as compared to stall barn operators (56% forestrip). Forestripping is adequate if 2-3 streams of milk are expressed. When teats are clean, forestripping should be performed prior to teat end disinfection. In parlors, cows can be forestripped onto the floor. This prevents the buildup of microorganisms in a fomite such as a strip cup. Cows in stall barns should never be forestripped into the bedding. Bulk milk SCC problems cannot be solved without the incorporation of forestripping into the milking routine.

The most dangerous bacteria reside at the teat end. Teat end disinfection is important in reducing the number of bacteria. It is well established that proper teat end disinfection, can reduce teat surface bacteria by 75%. Reduction in teat end bacteria numbers reduces the rate of mastitis. There is a considerable amount of confusion regarding how to best accomplish teat end disinfection. Wisconsin dairy farmers vary considerably in their practice of teat disinfection depending upon facility type (Table 5).

Table 5: Teat Disinfection Methods on 278 WI Dairy Farms

		Parlor Operators	Stall Barn Operators	Walk Through or Flat Barn
Predip	No	9 (10%)	51 (35%)	6 (24%)
	Yes	84 (90%)	95 (65%)	19 (76%)
Manually Wash	No	88 (95%)	93 (64%)	19 (76%)
	Yes	5 (5%)	53 (36%)	6 (24%)

The lowest milk bacterial counts have been shown to be produced with methods that wet and clean teats only. If cows are clean, teats can be adequately disinfected by the use of predipping without additional washing. Predipping is most effective in the control of environmental pathogens (*E. coli* and environmental *streptococci*) and has been shown to have limited effectiveness against coagulase negative staphylococci. [10,11] A minimum contact time of 20-30 seconds is needed for effective disinfection.

Washing is used both as the sole method of teat disinfection or preceding predipping. If washing is utilized, the following principles should be followed: 1) only teats should be washed, 2) minimal water should be used, 3) teats should be thoroughly dried.

4. Teats are Dry

The most important portion of the teat disinfection process is thorough drying of teat ends. Air drying is not a satisfactory substitute for manual drying with an individual cloth or paper towel. Wet teats allow skin bacteria easy access into the gland and reduces friction between the teat and the liner. In Wisconsin, individual paper or cloth towels are used by 87%, 75% and 85% of parlor operators, stall barn operators and walk through/flat barn operators respectively. Cloth towels have the advantage of being more absorbent than paper. When cloth towels are used they should be disinfected by washing with bleach or very hot water and drying at high temperature in an automatic dryer. These methods have been demonstrated to significantly reduce pathogen numbers. Additionally, the use of latex or nitrile gloves by milkers can help reduce pathogen transfer. Gloves both protect milkers skin and reduce the contamination of teats from milker's skin. Gloves can be easily changed between groups, further reducing the likelihood of pathogen transfer. In Wisconsin, a larger percentage of operators with parlors (89%) and walk through or flat barns (85%) have adopted the use of gloves as compared to stall barn operators (36%).

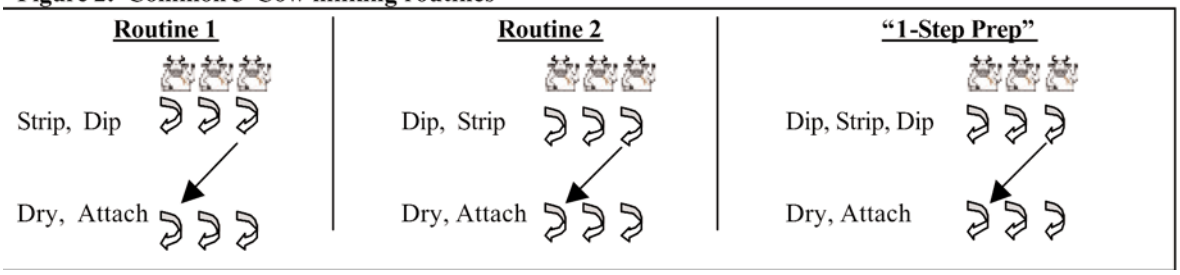
To check the effectiveness of teat disinfection and drying, a clean swab can be rubbed across the end of the teat prior to unit attachment. A swab from a properly prepared teat will remain clean. A dirty swab indicates that teat preparation methods should be improved.

5. Units are Properly Attached

An important element of the attachment process is timing. The time from the beginning of the cow preparation process until unit attachment is referred to as the "prep-lag" time. To maximize milking efficiency, units should be attached within one minute from *the beginning* of stimulation. A range of 45 seconds to 1.5 minutes is acceptable. Prep-lag times >3 minutes have been shown to result in more residual milk and lower milk yields.[8] A large flow of milk will be visible within a few seconds of unit attachment if prep-lag times have been optimized.

A primary decision in premilking routine, is deciding how many cows each operator will prep prior to unit attachment. Several common routines have been developed that utilize groups of 3 cows to ensure that prep-lag times and pre-dip contact time are optimized (Figure 2).

Figure 2: Common 3-Cow milking routines



A standardized process of unit attachment should be followed. To minimize air admission, the short milk tubes should be bent back over the claw ferrules. During the process of individual teatcup attachment, the teatcups are raised toward the teat, straightening the liner and minimizing air admission. Units should be adjusted and aligned so that cluster weight is evenly distributed. Units should be aligned so that the claw outlet is pointed at the head of the cow (conventional parlors) or directly between the legs in parallel parlors. Proper unit adjustment results in fewer liner slips. A goal of <5-10 slips per 100 cow milkings has been suggested as a thumb-rule.[4] A wide range of variation in unit reattachment rate was reported in the survey of Wisconsin dairy operators. While many operators reported a 0% reattachment rate, the maximum reported reattachment rate was 25%. As expected, milking efficiency on that dairy was exceedingly poor.

6. Units are Properly Removed

Milking is completed when the available milk is fully harvested. Undermilking occurs when all the milk is not removed ("not milked out") and overmilking occurs when teatcups are attached to teats but milk is not flowing. The biggest danger of undermilking is financial. The biggest danger of overmilking is damage to teat ends resulting in mastitis. Most stall barn operators are dependent upon visual observation and experience to determine when milking is completed. Only 15% of surveyed farmers with stall barn operations reported using automatic take off units (ATO). Stall barn operators that utilized ATO's were consider-

ably more efficient than stall barn operators that did not have ATO's (Table 6).

Table 6: Reported milking efficiency in stall-barn operations in Wisconsin

	Number of Herds	Average CPHPO[a]	95% Confidence Interval
Use ATO	23	29.3	25.2 – 33.5
No ATO	129	21.9	20.1 – 23.6

[a]cows per hour per operator

Ninety-three percent of most parlor and flat-barn/walkthrough parlor operators surveyed reported that they utilized ATO's. Adjustments in the ATO settings can improve milking time and teat end condition. A Danish experiment demonstrated that when the threshold setting on the ATO was raised from .44 to .90 lb/minutes the average unit on-time was reduced by 0.5 minutes and teat condition improved. Additional time savings can be gained by changing the detacher delay time after the threshold is reached from 20-30 sec to 10 seconds. To avoid milk yield loss, changes in detacher delays should be made gradually in three second intervals. High threshold settings and short detacher delays will apply to 3X herds with a good cow prep, resulting in improved teat condition and milking speed.

Manual cluster removal should mimic the ATO process. Vacuum should be shut off and the four teatcups removed together.

The completeness of milk-out can be estimated by occasionally checking the amount of milk that can be hand stripped from a cow after milking is completed. Left-over milk that can be expressed by hand milking is termed strip-yield. Cows can be considered to be fully "milked out" if <1 cup of milk per quarter can be hand stripped post-milking. Hand stripping should not be practiced routinely.

7. Cows are Managed Post-Milking

Post-milking teat antisepsis was initially developed to reduce the transmission of contagious mastitis pathogens and has been widely accepted. Ninety-five percent of surveyed WI farms reported using either teat dipping (80%) or spraying (20%). Teat spraying is more common in parlor operations. Spray applicators are preferred by some operators because of convenience and to keep teat dip from becoming tainted with contaminated milk. While it is theoretically possible to adequately cover the teat using a spray applicator, in reality it is difficult to accomplish. To evaluate the adequacy of teat spraying, a paper towel can be wrapped around the teat after dipping. A properly dipped teat will have teat dip completely around the towel.

Many producers temporarily discontinue teat dipping in subzero weather. An alternative strategy is to post-dip teats, allow 30 seconds contact time and then dry the teats off prior to releasing the animals.

Finally, the last step in an effective milking routine is to ensure that the cows remain standing for at least 30 minutes after milking is completed. Most producers provide fresh feed to encourage this behavior.

References

1. Reneau, J. K. Factors to Consider in Udder Preparation for Quality Milk Production. 1997. Milker Training Seminar, St. Cloud MN.
2. Doumalin, L. 1995. 1995 Variation des taux cellulaires. Le batiment, pre mier responsible. Production Latiere Moderne, fev. Rennes, France.
3. Sargeant, J. M., H. M. Scott, K. E. Leslie, M. J. Ireland, and A. Bashirl. 1998. Clinical mastitis in dairy cattle in Ontario: frequency of occurrence and bacteriological isolates. Can Vet J, 39:33-38.
4. Mein, G.A., and D. A. Reid. 1996. Milking-time test and guidelines for milking unit. Pp 235 in Proc. 35th Ann. Mtg. Natl. Mastitis Counc., Nashville, TN. Natl. Mastitis Coun., Inc., Madison, WI.
5. Thomas, C.V. 1995. Comparing parlors: performance and economics. Pp 299 in Proc. From Designing a Modern Milking Center Natl Conf., Rochester, NY, Nov 29-Dec 1, 1995. NE Regional Agr. Eng. Service, Ithaca NY.
6. Rasmussen, M.D., and E. S. Frimer. 1990. The advantage in milking cows with a standard milking routine. J. Dairy Sci. 73:3472-3480.
7. Reneau, J. K. and J. P. Chastain. 1995. Premilking cow prep: Adapting to your system. Pp 46 in Proc. Regional Meeting. Natl. Mastitis Counc., Harrisburg, PA. Natl. Mastitis Counc., Inc., Madison, WI.
8. Rasmussen, M.D., E.S. Frimer, D.M. Galton, and L.G. Petersson. The influ ence of premilking teat preparation and attachment delay on milk yield and milking performance. 1992. J Dairy Sci. 75:2131-2141.
9. Galton, D.M., L.G. Petersson and W. G. Merrill. 1986. Effects of premilking udder preparation prac tices on bacterial counts in milk and on teats. J. Dairy Sci. 69:260-266.
10. Pankey, J. W., E. E. Wildman, P.A. Drechsler, and J. S. Hogan. Field trial evaluation of premilking teat disinfection. 1987. J Dairy Sci., 70:867-872.
11. Ruegg, P.L. and I. R. Dohoo. 1997. A benefit to cost analysis of the effect of pre-milking teat hygiene on somatic cell count and intra-mammary infec tions in a commercial dairy herd. Can Vet J;38:632 -636.
12. Fox, L.K. 1997. Effectiveness of laundering udder cloth towels to reduce mastitis pathogens. J Dairy Sci. 80 (Suppl. 1):234.
13. Rasmussen, M.D., 1993. Influence of switch level of automatic cluster removers on milking performance and udder health. J Dairy Res. 60:287-297.

Appendix 1
Survey of Milking Routine on Wisconsin Dairy Farms
November 1998 - January 1999

Method: One-page (17 question) surveys on milking routine were distributed to dairy consultants (extension agents, dairy veterinarians and vo-ag instructors) in November 1998 with instructions to administer them to clients and return them by January 15, 1999. Of 345 surveys returned, 338 surveys representing 42,718 cows were included in the final data set. Data was analyzed using Statgraphics.

Demographic Results:

Type of Operation:	Parlor Operations	Stall Barn Farms	Flat Barns/Walk Through
Number of Herds	105	205	27
No. of Cows			
Median	195	54	120
Minimum	20	15	11
Maximum	1,350	200	361
RHA (lbs)	22,605	20,557	22,286
SCC			
Median	223,000	200,000	180,000
Minimum	75,000	4,000	79,000
Maximum	500,000	700,000	550,000
No. Milkers per milking	1.86	1.77	1.53
No. Family milking per Milking	0.83	1.55	0.96
No. Milkers per Month	5.6	2.6	4.6
No. Units Used	15.8	5.2	8.0
Cows per Hour per Operator	37.1	22.0	30.6
Turns per Hour	4.2	6.8	5.8
% using Gloves	87.5%	32.7%	81.4%
% using ATO	91.4%	14.2%	88.9%
% 3X	32.4%	2.4%	33.3%
Years since system update	5.8	11.2	3.9

Standard Milking Procedures
for stall barns

Background:
Cows need to be calm and clean before milking. The stress hormone "adrenaline" is released prior to milking. Adrenaline will interfere with oxytocin and prohibit normal milk letdown. Cows that are excited or frightened move rapidly, may slip, and often defecate while being moved into the milking facility. Disturbances within 30 minutes of milking can interfere with milk letdown.

Procedure:
- Hand washing is the first step in a high quality milking procedure.
- Wearing nitril or latex gloves will minimize the spread of mastitis-causing organisms between cows during milking. Gloves also protect the workers skin.
- Recommended milking practices include the following steps:

•Forestripping
Effective premilking stimulation consists of 10-20 seconds of teat stimulation. Forestripping is the best method of premilking udder stimulation. It is also the only way to identify cows that have clinical mastitis. The proper method of forestripping is to express 2-3 streams of milk per quarter. In stanchion barns, milk can be forestripped into an adequately sized strip cup. Milk should never be forestripped onto the bedding platform as it can contaminate the bedding with mastitis pathogens.

•Predipping
Premilking sanitation can be achieved by predipping the teats with a sanitizing product such as 0.5% iodine. At least three-fourths of each teat should be covered with the predip solution. Predip must remain in contact with the teat for 30 seconds before drying. In a stanchion barn or walk-through flat parlor, it is difficult to achieve 30 seconds of contact time if the operator is individually prepping and attaching milk units one at a time.

Note: If using saniwipes, this step can be eliminated.

•Drying Teats
Teats only (not the base of the udder) should be dried with a single use cloth or paper towel. The teat should be vigorously dried with special attention paid to the teat end.

•Attaching Milking Unit
The milking unit should be attached within one to two minutes after teat stimulation. This time period is termed "prep-lag time." It is critical in achieving good milk letdown. Oxytocin is the hormone responsible for milk letdown. Blood oxytocin levels peak at about 60 seconds. The objective is to coordinate milk letdown with milk unit attachment. Attachment should be done carefully to minimize the admission of air into the milking system. Good milk letdown has occurred when the milk flows immediately after the milk unit is attached.

•Detaching Milking Unit
It is normal to have about 2-4 cups of milk left in the udder at the completion of milking. Automatic take offs (ATOs) are recommended because they do the most consistent job of removing the milk unit. It is important that cows are not overmilked. ATO settings should be adjusted to current standards.

•Postdipping
The lower one-third of each teat must be dipped with a reputable teat antiseptic product after every milking.

Good Milking Key Points
The following points are crucial in a good milking routine:
- 30 second contact time
- One to two minute prep-lag time
- Good milk letdown

RESOURCES MILK MONEY

Standard Milking Procedures for milking parlors

Background:

Cows need to be calm and clean before milking. The stress hormone "adrenaline" is released prior to milking. Adrenaline will interfere with oxytocin and prohibit normal milk letdown. Cows that are excited or frightened move rapidly, may slip, and often defecate while being moved into the milking facility. Disturbances within 30 minutes of milking can interfere with milk letdown.

Procedure:

- Hand washing is the first step in a high quality milking procedure.
- Wearing nitril or latex gloves will minimize the spread of mastitis-causing organisms between cows during milking. Gloves also protect the workers skin.
- Recommended milking practices include the following steps:

• Forestripping

Effective premilking stimulation consists of one to two minutess of teat stimulation. Forestripping is the best method of premilking udder stimulation. It is also the only way to identify cows that have clinical mastitis. The proper method of forestripping is to express 2-3 streams of milk per quarter. In the parlor, milk can be forestripped directly onto the platform and washed between sides.

• Predipping

Premilking sanitation can be achieved by predipping the tests with a sanitizing product such as 0.5% iodine. At least three-fourths of each teat should be covered with the predip solution. Predip must remain in contact with the teat for 30 seconds before drying. Note: If using saniwipes, this step can be eliminated.

• Drying Teats

Teats only (not the base of the udder) should be dried with a single use cloth or paper towel. The teat should be vigorously dried with special attention paid to the teat end.

• Attaching Milking Unit

The milking unit should be attached within 40-90 seconds after udder stimulation. This time period is termed "prep-lag time." It is critical in achieving good milk letdown. Oxytocin is the hormone responsible for milk letdown. Blood oxytocin levels peak at about 60 seconds. The objective is to coordinate milk letdown with milk unit attachment. Attachment should be done carefully to minimize the admission of air into the milking system. Good milk letdown has occurred when the milk flows immediately after the milk unit is attached.

• Detaching Milking Unit

It is normal to have about 2-4 cups of milk left in the udder at the completion of milking. Automatic take offs (ATOs) are recommended because they do the most consistent job of removing the milk unit. It is important that cows are not overmilked. ATO settings should be adjusted to current standards.

• Postdipping

The lower one-third of each teat must be dipped with a reputable teat antiseptic product after every milking. This is an important step in controlling contagious mastitis organisms.

Good Milking Key Points

The following points are crucial in a good milking routine:

- 30 second contact time
- One to two minute prep-lag time
- Good milk letdown

RESOURCES MILK MONEY

Milking Routine Analysis

Name:	
Address:	
HERD CODE: RELEASE CODE:	
Date:	
Reason:	

Actual Milking Time

START:	Operators	STOP:	Operators
AM START:		AM STOP:	
PM START:		PM STOP:	
3X START:		3X STOP:	

	Prep			Unit			Meter Data		
Cow	Stim. Time	Contact Time	P-L Time	On	Off	MILK	MIN 1 FR	AFR	Residual Milk

Side*	Push Exit	1st Cow Prep	Last Unit On	
1				
2				
1				
2				
1				
2				
1				
2				
1				
2				

*record sequential sides

Calculate Parlor Performance:

A: Cow Movement Time = “1st cow Prep” - “Push Exit”: _____

B: Prep & Attach Time = “Last Unit On” - “1st Cow Prep” _____

C: Detach and Post dip = “Push Exit Side 2” - “Last unit on side 1 _____

Group	Start	Stop	Duration	No. Units	No. Milked	TIME/COW
1						
2						
3						
4						

Overall time = (duration x units) divided by No. cows

Step	Milker 1:		Milker 2:		Milker 3:		Milker 4:	
Forestrip								
Teat Wash		None Hose		None Hose		None Hose		None Hose
Predip		Dip Spray None		Dip Spray None		Dip Spray None		Dip Spray None
Teat Dry		Paper Cloth		Paper Cloth		Paper Cloth		Paper Cloth
		None Other		None Other		None Other		None Other
Attach								
Detach		Vacuum ATO		Vacuum ATO		Vacuum ATO		Vacuum ATO
Postdip		Dip Spray None		Dip Spray None		Dip Spray None		Dip Spray None
Other:								
Gloves		YES NO		YES NO		YES NO		YES NO

Milkers:

No. this milking _____ No. today _____ No. this week _____ No. this month_____

Cows:

Grouping Strategy:

Group	No. Cows	Milking Order	In Holding Pen	Feeding Order

Teat Condition Grid: YES NO

Cow	Letdown	Residual Milk RF LF RR LR	Cow	Letdown	Residual Milk RF LF RR LR

Udder Hair Removed: Yes No

Cow Environment

Stall type: Bedding: Cleanliness: Other:

Clinical Mastitis Records? Yes No **DHIA?** Yes No

Type of ATO:_____ Type of Inflation:_____ Regulatory Vacuum Level:_____

System:

No. units/stalls: Squawks: Start: Stop:

California Mastitis Test (CMT) Fact Sheet 1

Equipment

Milk samples from each quarter are collected in a clean CMT Paddle. The CMT paddle has four shallow cups marked A, B, C, and D to help identify the individual quarter from which the milk was obtained. The CMT solution should be reconstituted according to package instructions.

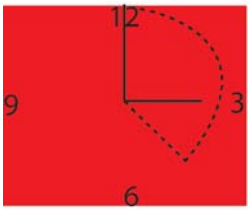
How to use CMT

Step 1:
Take about 1 teaspoon (2 cc) milk from each quarter.

This is the amount of milk that would be left in the cups if the CMT Paddle were held nearly vertical

Step 2:
Add an equal amount of CMT solution to each cup in the paddle.

Step 3:
Rotate the CMT Paddle in a circular motion to thoroughly mix the contents.
Do not mix more than 10 seconds.



Step 4:
Read the test quickly. Visible reaction disintegrates after about **20 seconds**. The reaction is scored visually. The more gel formation, the higher the score.

California Mastitis Test (CMT) Fact Sheet 1

from page 16

Reading the CMT

N = Negative
No infections. No thickening of the mixture. 100,000 SCC

T = Trace
Possible infections. Slight thickening of the mixture. Trace reaction seems to disappear with continued rotation of the paddle. 300,000 SCC
Example: If all four quarters read trace there is no infection. If one or two quarters read trace, infections are possible.

1 = Weak Positive
Infected. Distinct thickening of the mixture, but no tendency to form a gel. If CMT paddle is rotated more than 20 seconds, thickening may disappear. 900,000 SCC

2 = Distinct Positive
Infected. Immediate thickening of the mixture, with a slight gel formation. As mixture is swirled, it moves toward the center of the cup, exposing the bottom of the outer edge. When motion stops, mixture levels out and covers bottom of the cup. 2.7 million SCC

3 = Strong Positive
Infected. Gel is formed and surface of the mixture becomes elevated (like a fried egg). Central peak remains projected even after the CMT paddle rotation is stopped. 8.1 million SCC

Rinse Paddle
Remember to rinse the CMT paddle after each test.

Interpretation of CMT scores

CMT scores are directly related to average somatic cell counts. The following table shows how they are related.

Any reaction of T (trace) or higher indicates that the quarter has subclinical mastitis.

CMT Score	Somatic Cell Range	Interpretation
N (Negative)	0 – 200,000	Healthy Quarter
T (Trace)	200,000 – 400,000	Subclinical Mastitis
1	400,000 – 1,200,000	Subclinical Mastitis
2	1,200,000 – 5,000,000	Serious Mastitis Infection
3	Over 5,000,000	Serious Mastitis Infection

Other examples of CMT readings

Clinical Infection

Toxic Milk
(No reagent was added to the CMT paddle.)

California Mastitis Test (CMT) Fact Sheet 2

The California Mastitis Test (CMT) is a quick, simple test that accurately predicts the somatic cell count of milk from individual quarters or on composite milk samples.

WHEN TO USE A CMT

1. Purchasing cows
2. Fresh cows
3. Assess dry cow therapy
4. Assist with lactation therapy
5. Identify infected quarters on cows with high linear scores

CMT FACTS

- For the best results, take CMT milk samples before milking. Foremilk makes the best sample.
- Use the CMT to identify infected quarters
- CMT results reflect only on infections in the udder
- Dirt, manure and other particles do not interfere with the CMT reading because there is no DNA.
- Culture any CMT positive quarter to identify the specific bacteria
- Never begin lactation therapy based on CMT readings alone.
- Wait two to three weeks after treating a quarter before again using a CMT.

HOW THE CMT WORKS

The accuracy of the CMT is founded on three principles:

1. Leukocyte (white blood cells) numbers greatly increase when an injury or infection affects mammary tissue.
2. Leukocytes: especially, polymorphonuclear leukocytes (PMNs) have large nuclei (DNA) compared to other cells or bacteria in milk.
3. Leukocyte cell walls are mainly lipid (fat).

The thicker the gel in the paddle trays, the more white blood cells are present in the milk sample. The increasing thickness of the gel measures the increasing severity of the possible infection.

CMT reagent is a detergent with a pH indicator added (reason for purplish color). When milk and CMT reagent are mixed in equal amounts, the CMT reagent dissolves or disrupts the outer cell wall and the nuclear cell wall of any leukocyte, which are primarily fat (detergent dissolves fat). DNA is now released from the nuclei. DNA will gel together to form a stringy mass. As the number of leukocytes increase in a quarter, the amount of gel formation will increase in a linear fashion. Gel formation is now scored or read on a scale (CMT Fact Sheet 1).

Taking Sterile Milk Samples

Background:

Part of mastitis control programs include microbiological analysis of milk from cows suspected of having mastitis. Culturing milk samples allows the identification of the bacteria that are causing the mastitis and the application of preventive management programs. Strict aseptic procedures must be used when collecting milk samples to avoid contamination with bacteria present on the skin of the cow, hands of the sampler and barn environment.

Equipment:

- Sterile single use disposable plastic vials with tight fitting caps
  - Vials should be at least 15 mls.
- Nitrile or latex gloves should be worn to reduce contamination of samples with bacteria present on the samplers' hands.
- Alcohol soaked cotton, gauze or baby wipes are needed for adequate teat sanitation.
- Vials should be labeled with permanent markers to identify the cow and quarter being sampled.
- If multiple samples will be collected, racks should be used for convenient handling.

Individual Quarter Milk Sample

Udders and teats should be clean and dry prior to individual quarter sample collection.

- A strip cup can be used to examine a cow suspected with clinical mastitis.
- Forestripping 3 streams of milk from the teat to be sampled removes contaminated milk from the teat canal. The use of this practice will reduce the likelihood that unusable contaminated samples will be obtained.
- Teat sanitation can be accomplished through the use of predipping with 0.5% iodine. The disinfectant must remain on the tests for 20 to 30 seconds prior to removal.
- It is important to thoroughly dry the teat with a single use cloth or paper towel.
- Special attention should be paid to the teat end to achieve adequate sanitation.
- 70% ethyl or isopropyl alcohol must be used to fully sanitize the teat end prior to obtaining the milk sample. The scrubbing of the teat end should be vigorous to fully sanitize the teat.
- Alcohol is an ideal antiseptic because it evaporates quickly and will not contaminate the milk sample. If multiple teats are sampled a separate swab

must be used for each sample.

- Sanitation is not complete until the surface of the swab remains clean after it is used.
- The cap should be removed from the sample vial without touching the inside and it should be held so that the inner surface faces down. This will prevent sample contamination.
- The vial should be held at an angle so that debris does not fall into it.
- Milk from the teat to be sampled can be directed at an angle into the sampling vial. A sample size of 3-5 ml is usually adequate.
- The cap should be immediately replaced after the sample is obtained.

Composite Milk Samples

Individual quarter samples are the most sensitive way to determine the type of mastitis pathogen that is present, but sometimes a "composite sample" is collected. The term composite milk sample refers to the collection of milk samples from all 4 quarters into a single sample vial. This type of sample is often used in herd screening programs for contagious mastitis pathogens such as *Strep agalactia* or *Mycoplasma bovis*. Composite samples are used to reduce the cost of sampling but generally result in some level of false negative results.

- Predipping is the first step in obtaining a composite milk sample.
- The process of teat preparation for obtaining composite milk samples is identical to that of obtaining individual quarter samples but the order of teat preparation is critical. To reduce cross teat contamination, sanitize the far teats before the near teats. Use individual alcohol swabs to sanitize each individual teat.
- After teats are prepared, obtain an equal volume of milk from each quarter into the same vial. The order of sampling is near teats before the far teats.
- Immediately after sampling, place samples on ice or in a refrigerator. Culture the milk within 24 hours of obtaining the sample.
- If samples cannot be cultured within 24 hours, store in a freezer as soon as possible. Isolation of staph and strep may be improved by freezing. The number of samples positive for *E. coli* may decline after freezing.

Summary:

The correct steps for taking sterile milk cultures are: Use Proper Equipment, Clean, Dry Teats and Udders, Forestrip Teats to be Sampled, Predip Teats, Dry Teats, Sanitize Teat Ends, Take Sample, Refrigerate or Freeze Sample

COLLECTING BULK TANK MILK SAMPLES

Background:

Bulk tank cultures are often used in milk quality programs to monitor the types of mastitis causing pathogens present in a herd.

· Determine mastitis pathogens present. Properly obtained bulk tank cultures are useful for determining specific contagious mastitis pathogens in a herd.

· Identify common bacteria. Bulk tank cultures also are useful for identifying the most common bacteria present in bulk tank milk.

· Bulk tank cultures ARE NOT an accurate way of estimating the number of infected cows in a herd.

Procedure

- The first step in collecting a bulk tank milk sample is to turn on the agitator for at least 10 minutes. Agitation ensures that the milk sample will represent all the milk in the tank.
- Collect all samples from the top of the bulk tank. Bulk tank milk samples should never be obtained from the tank outlet. This area is impossible to sanitize. Samples obtained from the outlet at the bottom of the tank give inaccurate results. Always collect bulk tank milk samples from the top of the bulk tank.
- There are two ways to obtain a milk sample from the bulk tank.

1. One way to obtain a milk sample is by using a dipper. The dipper must be clean and sanitized before taking the sample.

2. Samples can also be obtained by using a sterile pipette and syringe.

- It is important to remember that interpretation of results from a SINGLE bulk tank sample can often provide inconclusive results. Results from bulk tank milk samples must be combined with somatic cell counts, results of individual cow cultures and clinical mastitis records to be properly interpreted.
- Bulk tank milk samples should be immediately refrigerated until submitted to the laboratory. Freeze samples if more than 24 hours will pass before submitting samples to the laboratory.

Improving Accuracy of Bulk Tank Cultures:

- Accuracy of bulk tank milk testing can be improved by obtaining bulk milk samples on 3 to 5 consecutive days.
- The samples can be frozen each day and submitted to the laboratory together. After thawing, the laboratory can combine the samples and culture them as one sample. Results obtained in this way are more likely to give useful results.

"Flaming Udders"

Short hair on a cow's udder is easier to keep clean and dry than long hair. A clean, dry udder provides many benefits such as making it easier and quicker to prep cows, helps reduce somatic cell counts, reduces mastitis, and can help keep bacteria and coliform counts low. Udders with long hair make it harder to properly clean and dry the teats.

Many dairy producers have discovered it's faster and easier to singe off udder hairs than to try to clip and trim with clippers. Using a propane torch to singe off udder hair is quick for you and painless for the cow. When done right, you won't burn the cows' teats or udder.

Start by rubbing loose dirt, bedding and manure off the udder. Then slowly pass the flame six to eight inches below the udder. Wear a cotton or leather glove on one hand so you can wipe off the black singed hair or quickly tamp out any small flare ups.

Quickly pass the flame between the rear legs and along each side of the udder to singe the hair. Repeat as necessary. Make sure to do the udder singeing in an area where there are no flammable materials such as bedding, hay, or other dry easily ignited materials.

We recommend that you purchase a commercial flamer. However, it is possible to build such devices from a hand-held propane torch, a rubber hose, a regulator, and a metal neck and tip. Flatten the tip and make sure to shut the air holes in such a way that it creates a cool, yellow flame rather than a hot, blue flame.

For safety and convenience, we encourage you to purchase a commercial udder singeing unit. Commercial units come with a long hose and a burner that's wide enough to cover the entire floor of the udder.

Films to help you learn how to properly singe udders are available for a small fee on VHS, CD-ROM and free from the World's Best Milk Quality Web Site:

www.uwex.edu/milkquality.

For more information call toll free: **866.867.6455 - 866.TOP.MILK**

Milk Money Fact Sheet 03

Environmental Streps

Mike Maroney, DVM

Background:

Many Streptococcal species are present in the cow's environment. Sources of "environmental Streps." include manure, soil, bedding and many sites on the cows' body. Species of environmental Streps. include: *S. dysgalactiae*, *S. uberis, S. bovis* and *Enterococcus faecalis*. These bacteria are sometimes referred to as "non-ag." Streps. or Strep. species.

Symptoms:

All dairy herds must deal with mastitis caused by environmental Streptococcus because of their widespread presence in the environment. Herds that have controlled contagious mastitis may have more problems with environmental streps. Herds with environmental mastitis problems can have high bulk tank somatic cell levels and high levels of clinical cases.

Culturing of the bulk tank can indicate the level of streptococcal bacteria in the bulk tank. However the source of the bacteria can be from the teat skin (hygiene) or multiplication in the udder (mastitis). Bacterial Plate counts can be elevated due to cows with mastitis shedding very high numbers of this bacteria. Herds adopting a non-antibiotic treatment protocol for mild mastitis may experience elevated plate counts and an increase in the recurrence or relapse rate of clinical cases. The increase in relapse rate is due to the fact that the infection is never cured and clinical signs come and go.

Cows with mastitis caused by environmental Streps. generally have mild to moderate clinical signs. Their somatic cell count may be in the millions and can shed large numbers of bacteria into the bulk tank. This high level of shedding has led some researchers to believe that they can behave in a contagious manner.

Diagnosis:

Bacteriological culturing of the milk can be used to determine whether mastitis is caused by environmental Streptococcus. Some laboratories will report the results as non-ag Streps. or Strep. species. Other laboratories will report the species of Streptococcus present. This level of detail may be important in designing treatment protocols or assessing their effectiveness.

Treatment:

The spontaneous cure rate for subclinical mastitis caused by environmental Streps. has been reported to be around 65%. However spontaneous cures of clinical mastitis are reported to be low (<20%) and affected cows may have relapses if they do not receive appropriate antibiotic therapy.

Treat clinical cases of mastitis caused by environmental streps with approved intramammary antibiotic products for an appropriate number of treatments. Extended treatment periods (up to 6 days of intramammary treatment) to treat *Strep uberis* infections have been shown to result in cure rates that exceed 90%. In general environmental Streps. respond to penicillin-based antibiotics with the exception of some Enterococcus species.

Preventive Management:

The choice of bedding can influence the types of bacteria that your cows' udders are exposed to. Environmental streps. thrive in straw. They also thrive in cool, damp environments. Therefore grooming of stalls should be performed two to three times a day to remove manure and wet bedding.

For sand based stalls it is critical that the back 2 to 3 feet of each stall be cleaned and leveled at each milking. A weekly schedule of replacing sand in the freestalls will insure the stalls remain full of clean sand. Develop standard operating procedures for maintenance of clean comfortable stalls.

Make sure that employees responsible for stall maintenance and scraping alleys understand their role in mastitis prevention and control. Bedding cultures can be helpful to assess whether current practices are sufficient to keep environmental streptococcal counts low.

The dry period is a time when new subclinical infections can occur. The times of greatest risk for acquiring new infections during the dry period are two weeks after dry off and the prefresh/calving period.

Dry cow treatment will provide protection for the first two weeks of the dry period. The housing and bedding of the cows should be carefully scrutinized for the dry and prefresh groups and the calving pens. If a bedded pack is employed make sure not to overcrowd it. If pastures are used, make sure that they are in good condition.

Having multiple paddocks available allows grasses to recover after wet conditions. For the prefresh group, properly designed freestalls are usually more desirable than a bedded pack because you can control where the cow places her udder during this high-risk period.

Many farms are focusing on individual use calving pens with a complete change of bedding with each calving. Changing of the bedding with each calving does not allow the bacterial counts in the bedding to rise above acceptable levels. Internal teat sealants have been shown to be effective in limiting the amount of new infections during the dry period.

To minimize the risk that the milking machine could play a role in mastitis make sure to keep it properly maintained. Regular milking system analysis will ensure that the teat end vacuum is properly set and stable.

Stable teat end vacuum will reduce the chance of reverse jetting of bacteria into the mammary gland during milking. Proper premilking teat sanitation will decrease the amount of bacteria in the milk in the event that reverse jetting occurs. Good teat end stimulation (10-20 seconds) and a prep-lag time of one to two minutes will ensure good milk letdown and decrease overall machine on time. Keeping the inflations clean is also very important.

Milk Money Fact Sheet 04

Coliform Mastitis

Mike Maroney, DVM

Background:

Escherichia coli, *Enterobacter aerogenes*, *Klebsiella pneumoniae* and *Serratia marcesans* are four common coliform bacteria that cause mastitis. Coliform bacteria are normal inhabitants of soil, digestive tract and manure. They accumulate and multiply in contaminated bedding. Coliform numbers of 1,000,000 or more per gram of bedding increase the likelihood of an udder infection and clinical mastitis. *Klebsiella pneumoniae* is common in sawdust bedding, especially rough-cut sawdust that contains bark or soil.

Coliforms invade the udder through the teat sphincter when teat ends come in contact with coliform bacteria. Once coliform bacteria enter the mammary gland, they either multiply rapidly or remain dormant. As they are destroyed by the cow's immune system, coliforms release endotoxins (poisons) into the cow's body. These endotoxins cause many of the clinical signs associated with coliform mastitis such as high fever, depressed appetite, rapid weight loss, abnormal milk and decreased production.

There is a distinct seasonal pattern of new clinical infections associated with high temperatures, heavy rainfall and unstable weather conditions. Often severe cases occur in older high producing cows early in their lactation.

Symptoms:

All dairy herds have to deal with coliform mastitis to varying degrees due to their widespread existence in the environment. Even though coliforms may cause a high percent of all acute clinical cases, these organisms are responsible for less than five percent of the total infected quarters within a herd at any one time. In 5-15% of these cases, enough endotoxin is released to result in seriously ill cows and death.

Coliform bacteria are responsible for a great number of acute clinical mastitis cases in dairy cows. Severely affected cows may show signs of high fever, udder inflammation (swelling), depressed appetite, dehydration (sunken eyes), diarrhea, decreased production and abnormal milk. Abnormal milk may be watery with clots, however the appearance of abnormal milk is not a good indicator of what type of mastitis pathogen is present. Usually only one quarter per cow is clinically infected at a time. Coliform bacteria are also capable of producing subclinical infections that persist for longer periods of time. It is usually not effective to treat these infections because the majority are eliminated by the cows' immune system.

Diagnosis:

Bacteriological culturing of the milk can be used to determine if mastitis is caused by coliform bacteria. However, in severe clinical cases the results will not be known in time to affect the treatment. Results from previous severe cases can help the veterinarian or herdsperson make better treatment decision.

It is not uncommon to get no growth when culturing abnormal milk from coliform infections because the cow's immune system has destroyed the bacteria by the time the milk sample is collected. On farm culturing has been gaining popularity and allows for results within 24 hours. Other farms employ a culturing strategy where they screen their fresh cows with a CMT paddle and all positive quarters are cultured. If the cow comes down with clinical mastitis in the first ninety days of lactation they then treat according to their subclinical culture results and treatment protocol.

Treatment:

For severe cases, many farms call their herd veterinarian for treatment or to devise a treatment protocol. Intramammary antibiotic therapy has little, if any, effect on improving the outcome of clinical mastitis caused by coliform bacteria.

Most mastitis caused by Gram-negative bacteria (coliforms) is mild or moderate. The immune response of the cow is highly successful in destroying these bacteria. As the bacteria are destroyed, endotoxin, which is a component of their cell wall, is released. Treatment for severe cases generally includes: Fluid therapy, anti-inflammatories, steroids, and systemic antibiotics with Gram-negative activity. Systemic antibiotic are warranted because more than 40% of severely ill animals will experience bacteremia (bacteria circulating in the bloodstream). A recent study indicated more favorable clinical outcomes for cows with severe clinical coliform mastitis that received IM ceftiofur once daily as compared to cows that received only supportive therapy. Treatment with oxytocin and frequent milk out is commonly included in mastitis treatment protocols. However, research has not shown these practices to be effective.

Prevention:

Maintain an adequate amount of bedding in confinement stall barns to provide a dry, comfortable bed for the cows. Grooming of stalls should be performed two to three times a day to remove manure and wet bedding. For sand based stalls it is critical that the back 2 to 3 feet of each stall be cleaned and lev-

eled at each milking. A weekly schedule of replacing sand in the freestalls will ensure the stalls remain full of clean sand. Develop standard operating procedures for maintenance of clean comfortable stalls. Make sure that employees responsible for stall maintenance and scraping alleys understand their role in mastitis prevention and control. Bedding cultures can be helpful to assess whether current practices are sufficient to keep coliform counts low.

The dry period is a time when new subclinical infections can occur. Research indicates that 50% of the clinical coliform infections, occurring in the first 90 days of lactation, actually started in the dry period. The times of greatest risk for acquiring new infections during the dry period are two weeks after dry off and the prefresh/calving period. Therefore the housing and bedding of the cows should be carefully scrutinized for the dry and prefresh groups and the calving pens. If a bedded pack is employed make sure not to overcrowd it.

If pastures are used, make sure that they are in good condition. Having multiple paddocks available allows grasses to recover after wet conditions. For the prefresh group, properly designed freestalls are usually more desirable than a bedded pack because you can control where the cows places her udder during this high-risk period. Many farms are focusing on individual use calving pens with a complete change of bedding with each calving. Internal teat sealants have been shown to be effective in limiting the amount of new infections during the dry period.

To minimize the risk that the milking machine could play a role in coliform mastitis make sure to keep it properly maintained. Regular milking system analysis will ensure that the teat end vacuum is properly set and stable. Stable teat end vacuum will reduce the chance of reverse jetting of bacteria into the mammary gland during milking. Proper premilking teat sanitation will decrease the amount of bacteria in the milk in the event that reverse jetting occurs. Good teat end stimulation (10-20 seconds) and a prep-lag time of one to two minutes will ensure good milk letdown and decrease overall machine on time. Keeping the inflations clean is also very important.

J-5 and similar vaccines are beneficial in limiting the severity of clinical signs from coliform infections. For vaccines to be effective, label directions must be followed. Keep in mind that these vaccines do not prevent new infections and are not a substitute for proper management of housing areas.

Mycoplasma Mastitis
Can you Control it on Your Farm?

Pamela Ruegg, DVM, MPVM

Introduction

Mastitis is a well-recognized and costly disease of dairy cattle. Most farmers are well acquainted with traditional causes of mastitis such as *Staphylococcus aureus* and *Streptococcus agalactia*. The widespread adoption of standard mastitis control practices such as teat dipping, dry cow therapy, appropriate treatment, judicious culling and good milking preparation has allowed many dairy farmers to control contagious forms of mastitis. In a recent study, *Staph aureus* and *Strep ag* accounted for only 8% of clinical mastitis cases in Ontario dairy herds.[4] While these traditional forms of mastitis are now controllable, mastitis continues to require management attention.

Fig 2: Mycoplasma Diagnosis in Wisconsin

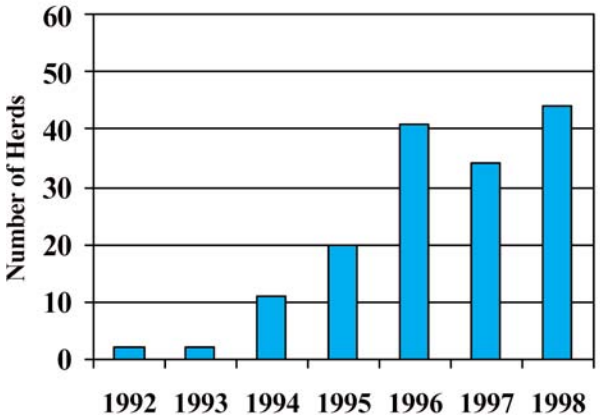
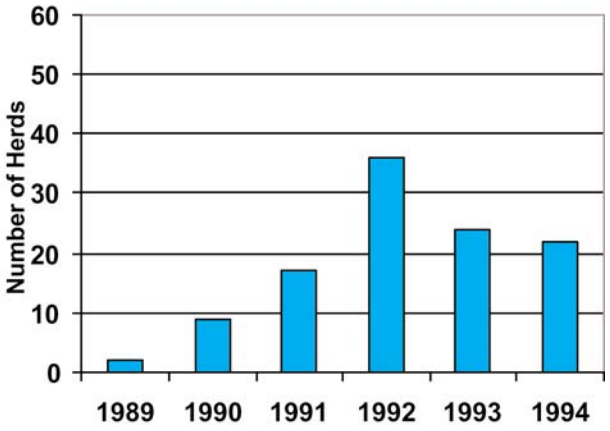


Fig 3: Mycoplasma Diagnosis in New York



Other organisms have emerged to fill the niche created by the control of contagious organisms. An organism that is increasingly isolated from clinical mastitis in Wisconsin is *Mycoplasma bovis* (Fig 2). Prior to 1992, there were only 2 confirmed herd outbreaks within Wisconsin, between 1992 and 1998 at least 140 herd outbreaks of that organism were reported.[5] A similar trend has been reported from dairies in New York (Fig 3).[2] Mycoplasma mastitis was once considered to be a disease of large western dairy herds. In recent years it has become recognized in Midwest and Northeastern dairy regions. This presentation will review basic facts about mastitis caused by mycoplasma and discuss control strategies to minimize the risk of an outbreak.

What is Mycoplasma?

Mycoplasmas are a group of very small organisms that can be cultured from multiple body sites of both sick and healthy cattle. Some common species of mycoplasma include *M. bovis* (most commonly cultured from the udder), *M. alkalescens* (commonly cultured from the respiratory tract, *M. bovigenitalium* (commonly cultured from reproductive tract) and *M. canadense* (commonly cultured from joints).

While many of these organisms have been isolated from bovine mastitis, *M. bovis* is the most common mycoplasma species isolated from milk samples in Wisconsin.

What diseases (other than mastitis) can be caused by Mycoplasma?

M. bovis lives naturally in the respiratory tract of cattle throughout the world.[3] Most respiratory tract colonizations of mycoplasma do not produce symptoms of disease but *M. bovis* is an important cause of respiratory disease in calves and feedlot cattle. Mycoplasma has also been implicated in joint infections, occasional abortions and ear infections in calves.

What Does Mycoplasma Mastitis Look Like?

The classic symptoms of mycoplasma mastitis have been described:[3]

- Multiple quarters involved
- Dramatically decreased milk production
- Cows appear otherwise healthy but have severe mastitis
- Milk has sandy or flaky sediments in watery or serous fluid

However, cows can develop subclinical infections with mycoplasma and have normal appearing milk.[1] These subclinically infected cows may have intermittent periods of abnormal milk or their milk may continually appear normal. Somatic cell counts of subclinically infected cows will be increased. Cows that have had mycoplasma cultured from their milk should be considered to be permanently infected regardless of the visual appearance of their milk.

How is Mycoplasma Mastitis Diagnosed?

Bacteriologic culture of milk is required for the diagnosis of mycoplasma mastitis. Milk samples from infected quarters, composite milk samples from infected cows or bulk tank samples can be submitted for culturing. Not every mastitis laboratory performs cultures for mycoplasma because special techniques must be used to grow this organism. The Wisconsin Animal Health Laboratory is one Wisconsin laboratory that performs mycoplasma cultures. Even at laboratories that offer mycoplasma culture, the culture is not performed unless it is specifically requested. To detect mycoplasma, milk is plated on different media and incubated for 7 days in a special incubator. In milk samples obtained from individual cows, a negative mycoplasma culture usually means that the organism is not present. However, intermittent shedding of the organism has been reported, so false negative cultures may rarely occur.[3]

Bulk tank culturing is a good way to monitor a herd for the introduction of mycoplasma mastitis. Detection of as few as one infected cow in bulk tank milk from a 1000 cow dairy has been reported.[1] Like cultures of individual cow milk samples, periodic shedding patterns may lead to an occasional false negative bulk tank sample in a herd with infected cattle.

How Does Mycoplasma Mastitis Spread?

Mycoplasma mastitis is classified as a contagious mastitis pathogen because the reservoir for the infection is other infected cattle, including calves. In contrast to other forms of contagious mastitis, mycoplasma infection can spread from the respiratory system to the udder. The spread can occur due to transmission through the air or through the blood stream. A history of respiratory disease or ear infections in calves occasionally precedes outbreaks of mycoplasma mastitis. A common source of infection is the purchase of cows subclinically infected with mycoplasma mastitis. Non-lactating animals are also at risk as they can be subclinically infected prior to freshening. After calving, these animals may never develop clinical mastitis but may shed high levels of mycoplasma organisms in their milk.[1] Transmission between cows can occur during the milking process or through contamination of cow contact areas in the environment.

How can Mycoplasma be Controlled?

The first step in controlling mycoplasma mastitis is recognizing that the disease is present in Wisconsin dairy herds. A strong association between the introduction of new cattle and outbreaks of mycoplasma mastitis has been reported.[1] Mastitis biosecurity programs can be used to decrease the risk of purchasing infected cattle. Bulk tank cultures from the herd of origin should be requested for non-lactating purchased cows and somatic cell counts and composite milk samples from individual cows should be reviewed prior to purchasing lactating cows. Cows that calve after purchase should be isolated until a negative composite milk sample is obtained. Herds that are routinely purchasing cattle should submit bulk tank milk for mycoplasma twice monthly.

The management of sick and fresh cows also contribute to the spread of this organism. Fresh cows should not be housed in the same pens or milked with the same equipment as sick cows. The feeding of waste milk to calves is another source of transmission of this disease throughout the herd. Calves fed infected milk may develop pneumonia, joint infections and head tilts related to ear infections.[1]

When mycoplasma is found in a bulk tank or individual cow culture, the number of infected cows must be determined. Depending upon herd size, there are several strategies that can be considered. If resources allow or the herd is small, composite samples from all cows should be submitted for culture. In larger herds, group milk samples can be submitted by sequentially culturing the bulk tank during milking. Individual milk samples can be obtained from cows only in the infected groups.

There is no treatment for cows that develop mycoplasma mastitis. Antibiotics are totally ineffective for this organism. Cows that are infected with mycoplasma should always be considered as infectious, regardless of their produc-

tion level, appearance of their milk or subsequent negative milk culture. In most cases, infected cows should be promptly culled. The only exception to this rule is when a culling is financially unacceptable because a large proportion of a herd is infected. In this case a herd specific strict segregation plan should be developed.

References

1. Blackmer PE. 1998. Mycoplasma mastitis in large dairy herds. Sharing 28 years of practice experience. PP 145 in Proceedings
of WI Vet Med Assoc, 84th Ann. Conf. WI Vet Med Assoc, Madison WI

2. Gonzalez RN, Sears PM. 1995. Occurrence of bovine mycoplasmal mastitis in herds and cows in the state of New York. PP
128 in Proceedings of Natl Mastitis Coun, National Mastitis Council, Madison WI.

3. Jasper DE. 1981. Bovine mycoplasmal mastitis. Adv Vet Sci Comp Med 25:121.

4. Sargeant JM, Scott HM., Leslie KE et al. 1998. Clinical mastitis in dairy cattle in Ontario. Frequency of occurrence and
bacteriologic isolates. Can Vet J 39:33.

5. Thomas C.B., 1998. Bovine mycoplasmas: A practitioners orientation to host and agent interactions. pp 255 in Proceedings of
WI Vet Med Assoc, 84th Ann. Conf. WI Vet Med Assoc, Madison WI

Milk Money Fact Sheet 05

Mycoplasma Mastitis

Mike Maroney, DVM

Background:

Mycoplasma are bacteria-like organisms that can cause diseases in animals. They differ from most bacteria by the fact that they lack a cell wall; instead they are enveloped in a membrane. Mycoplasma species are capable of causing mastitis, arthritis, reproductive disease, ear infections and respiratory disease in dairy cattle. *Mycoplasma bovis* is the most common species of mycoplasma to cause mastitis in dairy cows.

Mycoplasma mastitis is classified as a contagious mastitis pathogen because the infection can be spread from cow to cow during milking. The reservoir for the infection is the udder and lungs of other infected cattle. Unlike other forms of contagious mastitis, mycoplasma infection can spread from the respiratory system via the blood or lymph system to the udder.

Symptoms:

Herds with mycoplasma infections may experience an increase in mastitis that does not respond to treatment. This may lead to an increase in the death loss or culling rate due to mastitis. New infections may occur after the herd has experienced an outbreak of pneumonia. Management factors associated with mycoplasma outbreaks include: purchasing heifers, use of multi-dose intramammary infusions and inadequate milking procedures.

Cows with clinical infections may have abnormal milk that is often brown to tan with flaky sediment. Some milk samples may appear to have a sandy, granular appearance when allowed to settle. The infection may spread from one infected quarter to multiple quarters despite treatment. Frequently the affected cows' milk production will drop dramatically. Clinical mastitis symptoms may follow an episode of pneumonia. Subclinical infections do occur with or without elevated somatic cell counts.

Diagnosis:

Bulk tank culturing is a good way to monitor a herd for the introduction of mycoplasma mastitis. Like *S. aureus,* shedding patterns may lead to a false negative bulk tank sample. The dilution effect may also limit the ability of detecting a mycoplasma positive cow from a large herd. For this reason it is recommended to sample pens of no larger than 200 cows. Several companies market an insert to place in the milk line with a sampling port.

Individual cows with clinical mastitis may be cultured for mycloplasma. In milk samples obtained from individual cows, a negative mycoplasma culture usually means that the organism is not present. However, a false negative from an individual cow milk sample can occur.

For individual milk samples to be tested for mycoplasma, it must be specifically requested. To detect mycoplasma, milk is plated on selective media and incubated for seven days in a carbon dioxide incubator. Freezing milk samples will reduce the sensitivity of culturing. The sensitivity of a test is it's ability to correctly identify all the positive samples. Therefore, whenever possible, submit chilled, fresh samples.

Treatment:

There is no approved intramammary antibiotic that is effective for treatment of mycoplasma mastitis. Penicillin-based antibiotics that attack the cell wall are ineffective for mycoplasma. Cull infected cows promptly or strictly segregate the infected group and milk them last.

Do not use treatments from multiple dose vials for intramammary infusion. Only use FDA approved individual dose antibiotic preparations for intramammary treatment. During several outbreaks the staff of the farms have spread mycoplasma infections because the organism contaminated medicine bottles.

Prevention:

Prevention starts with a well thought out milking routine and properly functioning milking system. Essential elements of the milking routine include pre and post milking teat disinfection and use of individual towels to clean and dry teats. Properly ventilated barns are critical for all classes of livestock, because mycoplasma is also a respiratory pathogen. Some parts of the country experience a seasonal increase in the amount of positive bulk tanks during the colder months.

If your farm hasn't experienced mycoplasma mastitis and you're considering expanding it is a good idea to prepare a biosecurity program. A mastitis biosecurity program can decrease the risk of purchasing infected cattle. Begin a surveillance program for mycoplasma by setting up a milk culturing routine. Animals to culture would include: all newly purchased animals, fresh heifers and cows and clinical cases of mastitis.

Request to examine bulk tank cultures from the herd of origin. If possible, isolate purchased cows after calving until a negative composite milk sample is obtained. Do not house and milk fresh cows with the sick cows. Herds that are routinely purchasing cattle should routinely submit bulk tank milk for mycoplasma culture.

Frequent bulk tank milk culturing will provide an early warning if mycoplasma infected cows have entered your herd. Once you have a positive bulk tank for mycoplasma, then you will want to identify the affected cows. Smaller herds may choose to culture all the milking cows. However this can be an overwhelming task for large dairies. Pen or string sampling is a good strategy for larger herds. Remember not to move animals in or out of the pens while you are waiting for culture results.

Once you have identified affected pens, then you can culture a smaller number of cows. Once the affected cows are identified remove them from the milking string and submit another bulk tank sample for analysis. Either cull culture positive animals or isolate them into a separate group to be milked last. Remember the infected cows serve as a source for new infections.

Calves fed infected milk may develop pneumonia, joint infections and head tilts related to ear infections. Properly pasteurized waste milk will reduce the amount of mycoplasma below infective levels. Housing calves in properly ventilated buildings or huts will decrease their exposure to this respiratory pathogen.

Milk Money Fact Sheet 01

Staphylococcus aureus

Mike Maroney, DVM

Background:

Staphylococcus is a general name for a class of bacteria capable of causing mastitis (inflammation of the udder) in dairy cows. Mastitis caused by *S. aureus* is described as contagious. Surveys have reported isolating *Staphylococcus aureus* from bulk tank milk cultures in 43 to 92 percent of sampled herds. Clinical signs can range from abnormal milk to gangrenous mastitis. These pathogens may cause periodic episodes of mild to moderate mastitis that seem to resolve with or without treatment.

However, bacteriological cure of the affected quarter is rarely achieved. Infections are spread from infected cows to non-infected cows during milking via milking machines, milkers' hands, and teat cleaning materials such as towels used on more than one cow. Contact with milk secretions in stalls and bedded packs are a potential point of infection. Flies can serve as vectors of *S. aureus*, transferring it from one animal to another.

Staphylococcus aureus can be isolated from many body sites, including the teat skin and nose. Once *S. aureus* gets into the mammary gland, it invades deep into secretory cells and ductal tissue. Staph infections produce scar tissue and cause abscesses in the udder. This tissue destruction limits an infected quarter's ability to produce milk and to respond to treatment efforts.

Symptoms:

Herds with moderate to high levels of *S. aureus* commonly have elevated bulk tank somatic cell counts in the 300,000 to 750,000 cells/ml range. The percent of cows infected significantly increases with age and days in milk. This is because the milking process provides an opportunity to spread the infection. A majority of infected quarters at dry off will remain infected into the next lactation. The relapse rate of cows treated during lactation is high.

Cows infected with *S. aureus* may have multiple clinical episodes during the same lactation. The milk from infected cows may appear normal or be off-colored with flakes and clots. Somatic cell counts often are normal (<200,000 cells/ml) or slightly elevated for much of the lactation. Chronically infected cows may have abscesses or "knots" in their quarters that can be felt when the udder is milked out. During clinical episodes, quarters can show mild to moderate swelling and their somatic cell value can rise above 1,000,000 cells/ml. Rarely, a cow or heifer will develop gangrene or "blue bag" from a *S. aureus* infection. Infections can occur in heifers and at any time during lactation.

Diagnosis:

Culture the bulk tank to determine if *S. aureus* infections are present in the herd. Regularly monitor the bulk tank because the presence of *S. aureus* is variable. The frequency of bulk tank culturing should depend on the herd size and whether the farm is purchasing new animals. If *S. aureus* is present in the bulk tank, culture individual cows with somatic cell counts greater than 200,000 cells/ml (DHI linear scores > 4.0.)

S. aureus infections are characterized by intermittent shedding. Bacteria are not always shed in the milk at levels detectable by bacteriological culturing. Therefore, negative culture results do not guarantee that a cow is free of infection. To increase the probability of identifying all the *S. aureus* cows in the herd, consider the following recommendations:

Inform the bacteriological laboratory you are screening for *S. aureus* infected cows or quarters because the lab will use a larger amount of milk for each sample. Freeze samples after collection. Consider sending quarter rather than composite samples.

Finally, the likelihood of correctly identifying *S. aureus* infected cows is improved by sending in multiple samples collected from different milkings. Correct identification increases from about 70 percent to 90 percent by submitting at least three samples taken at different milkings.

Treatment:

It's not usually cost-effective to treat for *S. aureus* during lactation because reported cure rates commonly are around 25 percent. However, reported cure rates do vary considerably (5 to 70%). Differences in *S. aureus* strains probably contribute to this discrepancy. Treatment is more likely to work in the following situations: new infections (less than two weeks), single quarter infections, first lactation animals and in front quarters. Extended duration intramammary therapy may further improve cure rates. Consult with your herd veterinarian to design a treatment protocol and decision tree for your farm.

Preventive Management:

The "five-point plan" for mastitis control developed in the 1970's is a proven and effective method for controlling contagious mastitis caused by *S. aureus*. The five points are:

1. Post milking teat disinfection.
2. Dry cow treatment with antibiotics on all quarters of all cows.
3. Prompt treatment of clinical case of mastitis with antibiotics.
4. Regular milking system analysis and maintenance.
5. Culling chronically infected cows.

Regular bulk tank culturing will provide an early warning if *S. aureus* infected cows have entered the herd. Culturing all new arrivals to the herd is also a good biosecurity practice to limit the damage of introducing this mastitis pathogen to your herd.

Milker training is very important in contagious mastitis control. The milkers need to understand how the bacteria is spread in order to ensure that their milking habits are not contributing to the problem. The use of latex or nitrile gloves allows the milkers to easily disinfect their hands. Proper milking procedures, employee training and teat dipping can reduce the spread of *S.aureus* within your herd. Use of a single-use paper or cloth towels during the milking preparation procedure is recommended.

Separating the infected cows from the uninfected cows can help reduce the rate of spread of this mastitis causing pathogen. Grouping infected cows together and milking those animals last keeps milk from infected cows away from uninfected cows. Another technique is designating separate milking unit(s) only for infected cows. If you must use the same milking units for both infected and uninfected cows, then backflush between cows.

Herds grouping on *S. aureus* status should develop a continual, systematic culturing program to insure that infected cows remain separate from the uninfected group. Examples of these programs include: culturing all cows after they freshen, monthly examination of somatic cell records and culturing of suspect cows, culturing clinical cases, or periodic culturing of the uninfected group. Your herd veterinarian can help you design a program that will work for your farm.

House calves individually and avoid feeding waste milk from treated cows. Properly pasteurized waste milk will reduce the amount of *S. aureus* below infective levels.

Milk Money Fact Sheet 02

Streptococcus agalactiae

Mike Maroney, DVM

Background:

Streptococcus is a general name for a class of bacteria capable of causing mastitis (inflammation of the udder) in dairy cows. *Streptococcus agalactiae* (commonly called "*Strep ag*") is a common cause of subclinical and mild to moderate clinical mastitis infections in dairy cows. With subclinical infections the cows have an elevated somatic cell count without abnormal milk. Cows infected by *S. agalactiae* often have more than one infected quarter. Mastitis caused by *S. agalactiae* is described as contagious. Infections are spread from infected cows to non-infected cows during milking via milking machines, milkers' hands, and teat cleaning materials such as towels used on more than one cow.

S. agalactiae survives a very short time in the environment, but it can persist indefinitely within the mammary gland. Infected heifers and cows are the reservoir of *S. agalactiae*. The number of herds infected by *S.agalactiae* has been reduced by modern mastitis control programs. *S. agalactiae* can be eradicated from dairy farms, however it remains a biosecurity threat for dairies that purchase cattle.

Symptoms:

Herds with *S. agalactiae* mastitis frequently have bulk tank milk or DHIA weighted somatic cell counts that are consistently greater than 400,000 cells/ml with occasional counts reaching 700,000 cells/ml and greater. The standard plate count may occasionally rise above 100 colony-forming units (CFUs) in bulk tank milk, despite proper cleaning and sanitizing of milking and cooling equipment. Despite these alarming results the herd may only experience a monthly clinical mastitis rate of one or two percent. Heifers may freshen with "blind" or non-functional quarters. The herd may experience a very high cure rate (>70%)of clinical mastitis cases treated with approved intramammary antibiotics. DHI records may indicate rising somatic cell counts as cows get older and milk later in their lactation.

Cows' with *S. agalactiae* mastitis usually have elevated somatic cell counts but normal milk. Occasionally the cow may progress from subclinical to clinical mastitis. During episodes of clinical mastitis the signs are usually limited to abnormal milk and udder swelling. Cows affected by *S. agalactiae* infections can shed very high levels of the bacteria into the bulk tank and cause elevated plate counts.

Diagnosis:

Culture the bulk tank to determine if *S. agalactiae* is present within the herd. If S. agalactiae is confirmed in the bulk tank, aseptically collect milk samples for bacteriological culture from individual cows with somatic cell counts of 200,000 or higher (linear score of 4). Isolating *S. agalactiae* from greater than 15 percent of milk samples indicates a significant non-clinical mastitis problem.

Treatment:

S. agalactiae only lives in the udder of cows and 85-95% of infected cows are often cured by intramammary treatment using penicillin type drugs. Herd managers have two treatment options when trying to eradicate *S. agalactiae* from the herd. The first is called "blitz therapy." In this treatment scheme you treat all quarters of all cows with a penicillin type intramammary antibiotic tube for three milkings. Consult your veterinarian for advice on which antibiotic preparation to use. The second option is to culture and treat all cows that are diagnosed with *S. agalactiae* infections.

The difference between the treatment options is the cost of discarded milk versus the cost of additional bacteriological cultures. To determine what these costs are you may want to consult with your veterinarian. It will also be helpful to examine individual cows somatic cell counts or culture a group of cows to estimate the number of cows infected in the herd. Be sure to test the bulk tank for antibiotic residues after observing the appropriate withdrawal time.

A small percentage (5-15%) of treated animals will not be cured. Therefore three weeks after treatment, cows that continue to have high SCC values should be cultured again. You may retreat a second time, but segregate cows that remain chronically infected from the herd to prevent reinfection. These non-responding cows should be culled when economically feasible.

Treatment of cows subclinically infected with *S. agalactiae* usually results in increased production and dramatic decreases in bulk tank SCC values. Virtually all mastitis experts agree that treating *S. agalactiae* infections is economically beneficial.

Preventive Management:

The "five-point plan" for mastitis control developed in the 1970's has proven to be very effective for controlling contagious mastitis caused by *S. agalactiae*. The five points are listed here:

1. Post milking teat disinfection.
2. Dry cow treatment with antibiotics on all quarters of all cows.
3. Prompt treatment of clinical case of mastitis with antibiotics.
4. Regular milking system analysis and maintenance.
5. Culling chronically infected cows.

Regular bulk tank culturing will provide an early warning if *S. agalactiae* infected cows have entered the herd. Culturing all new arrivals to the herd is also a good biosecurity practice to limit the damage of introducing this mastitis pathogen to your herd.

Separating the infected cows from the uninfected cows can help reduce the rate of spread of this mastitis causing pathogen. This can be accomplished by grouping, designating a separate unit for infected cows or backflushing. It is very important not to spread the bacteria by using a paper or cloth towel on more than one cow, during the milking preparation procedure.

Milker training is very important in contagious mastitis control. The milkers need to understand how the bacteria can be spread in order to ensure that their milking habits are not contributing to the problem. The use of latex or nitrile gloves allows the milkers to easily disinfect their hands. Proper milking procedures, employee training and teat dipping can reduce the spread of *S. agalactiae* within your herd.

House nursing calves individually and avoid feeding waste milk from treated cows.

Calculating Monthly Clinical Case Rates

The monthly clinical case rate is calculated by dividing the number of clinical quarters by the number of lactating cows in the herd and multiplying by 100. A clinical case (quarter) is defined as abnormal milk with or without visible signs such as: swelling, hardness, redness, fever, inappetence and recumbency. The number of lactating cows in a herd is an average of the lactating cows present during the past month. If the same quarter is affected within 14 days, it should not be counted as a new case. This calculation is useful for determining the cost of clinical mastitis and it allows comparison of rates between herds. It is most accurate when calculated from farm records.

Example: Annual treatment records for a herd averaging 100 lactating cows is listed below:

Month	# Cases	
January	0	quarters treated
February	2	quarters treated
March	2	quarters treated
April	3	quarters treated
May	4	quarters treated
June	5	quarters treated
July	8	quarters treated
August	6	quarters treated
September	4	quarters treated
October	3	quarters treated
November	2	quarters treated
December	1	quarters treated
Yearly Total	40	quarters treated

July Treatment Records

COW ID	DATE	RR LR	RF LR	CLINICAL SIGNS
88	7/1	X		Flakes
Lilly	7/5		X	Flakes
36	7/5	X	X	Fever, Swelling Clots
42	7/8			Flakes
			X	
36	7/15	X		Swelling, Clots
42	7/12			Flakes
		X		
88	7/25	X		Fever, Swelling Clots
36	7/29			Swelling, Clots
		X		

Clinical case rate = (40 quarters/ 100 cows) X 100 = 40%

Discussion: Cow **#88** had 2 clinical episodes in July because the same quarter was affected twice and more than 14 days elapsed between episodes. Cow **#36** had 3 clinical episodes, the first two occurred within 14 days in the same quarters so are only counted once. The last episode was in a different quarter so is counted as a new case even though it occurred within 14 days. Cow **#42** had 2 episodes within 14 days but in different quarters, therefore they are counted as 2 cases.

* The method for calculating clinical case rate may vary. The calculations cited above will be used in "Milk Money" for validity and repeatability. This fact sheet prepared by Dr. Pamela Ruegg and Dr. Michael Maroney, October, 2001.

TREATMENT PROTOCOLS

Treatment protocols are used to define standard treatments for common diseases on dairy farms. Treatment protocols are important when multiple people have responsibility for administering antibiotic treatments to dairy cattle or when extra label drug use is prescribed.

Extra label drug use is any use of drugs that is not specifically mentioned on the product label.

A requirement for legal extra label drug use in food animals is the existence of a valid veterinarian/client/patient relationship (VCPR). A key requirement of the VCPR is that "the veterinarian has assumed the responsibility of making medical judgements regarding the health of the animals and the need for medical treatment and the client (owner or caretaker) has agreed to follow the instructions of the veterinarian." Documentation (such as clinical mastitis records) of extra label drug use is required.

Treatment protocols are a communication tool about treatment plans between the veterinarian and client and allow the farm to partially fulfill requirements for legal extralabel drug use. The use of treatment protocols is highly associated with the adoption of clinical mastitis records and longer milk discard times. Farms participating in the WI quality teams that had treatment protocols were 6.5 times more likely to maintain clinical mastitis records and discarded milk for one-half day longer.

Treatment protocols can be simple but should be defined by consultation between the local veterinarian, farm owner and key animal caretakers.

Example of Treatment Protocol for Clinical Mastitis

Clinical Signs			
Abnormal Milk	Give oxytocin, put leg band on	Use 1/4 milker for 2 milkings	Recheck, remove band if normal, take sterile culture if not normal
Abnormal milk plus swollen udder	Give oxytocin, put leg band on	Freeze sterile milk sample, give 1 intra-mammary tube for 2 milkings, put in sick pen	
Abnormal milk plus swollen udder or plus temp. > 103, off feed, down in milk	Give oxytocin, put leg band on	Freeze sterile milk sample, give 1 intra-mammary tube for 2 milkings, 2 aspirin, put in sick pen	Recheck 2 hours later, give hypertonic saline if temp > 103.5, CALL VET if not improved 2 hours after saline
Down & Dehydrated →			**CALL VET**

Herd Mastitis Treatment Record

	Cow ID	Dry Date	Dry Treat	CMT(+/-) Quarter		Fresh Date	Fresh Culture Result		Mast Date	Affected Quarter		Treatment	Duration				CM Cult Result
1				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
2				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
3				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
4				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
5				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
6				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
7				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
8				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
9				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
10				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
11				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
12				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
13				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
14				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
15				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	

	Cow ID	Dry Date	Dry Treat	CMT(+/-) Quarter		Fresh Date	Fresh Culture Result		Mast Date	Affected Quarter		Treatment	Duration				CM Cult Result
1				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
2				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
3				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
4				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
5				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
6				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
7				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
8				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
9				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
10				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
11				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
12				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
13				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
14				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	
15				LR	LF		LR	LF		LR	LF		AM	AM	AM	AM	
				RR	RF		RR	RF		RR	RF		PM	PM	PM	PM	

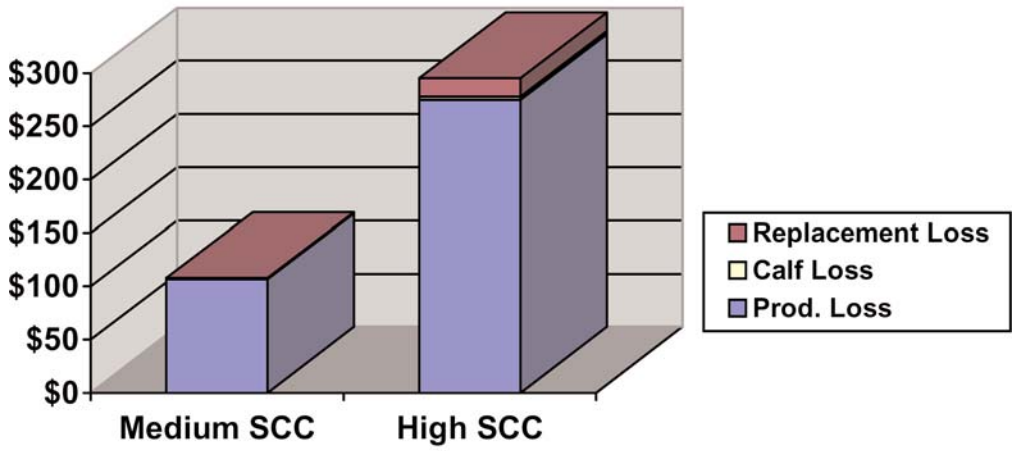
Premiums, Production and Pails of Discarded Milk How Much Money Does Mastitis Cost You?

Pamela Ruegg, DVM, MPVM
University of Wisconsin, Madison

Introduction

Profit centered dairy farms strive to maximize milk price and control costs. One way to control costs is by minimizing the rate of disease. The most costly disease of dairy cattle is generally considered to be mastitis. Mastitis can cause both clinical and subclinical disease. On many farms, subclinical mastitis is the most economically important type of mastitis because of the long-term effect of chronic infections on total milk yields. Persistent long-term infections with contagious pathogens (such as *Strep agalactia* and *Staph aureus*) damage milk secretory cells and result in reduced milk production.[6] A recent study estimated that the cost of subclinical mastitis to the US dairy industry exceeds $1 billion annually.[4] The effect of subclinical mastitis is shown in the somatic cell count (SCC) at the individual cow level and ultimately in the bulk tank. The SCC of cows infected with subclinical mastitis rises as the cows immune system sends white blood cells to the udder to fight off mastitis pathogens. The association between herd bulk tank SCC and production losses was recently compared between herds with low SCC (<200,000/ml), herds with medium SCC (200,000-399,999) and herds with high SCC (>400,000/ml), (Figure 1).[4] The overall production loss for the average US dairy farm was estimated at $110/cow annually.

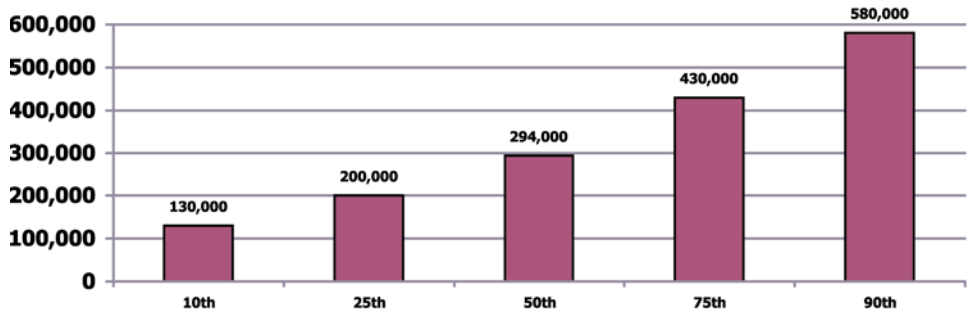
Figure 1. Production Losses Associated with Subclinical Mastitis



(adapted from Ott, 1999)

Higher bulk tank SCC levels are not considered desirable by most milk purchasers as high SCC reduces quality and yield of dairy products (such as cheese). Therefore, most milk purchasers pay premiums for higher quality milk. Controlling subclinical mastitis and producing lower SCC milk, therefore, represents a potential profit opportunity associated with both increased production and increased milk price.

Figure 2. Distribution of Wisconsin Grade A Dairy Herd SCC, 1998



Through the adoption of standard mastitis control programs, many Wisconsin dairy herds have achieved a high level of control of contagious mastitis that is reflected in their bulk tank SCC (Figure 2). In 1998, the top 25% of Wisconsin dairy herds produced milk with an average bulk tank SCC of <200,000 and fully half of the herds (and a higher percentage of the milk) was produced by herds with an annual bulk tank SCC of less than 300,000/ml. Herds with low SCC may have minimized losses due to subclinical mastitis but still be incurring losses due to clinical mastitis.[1] In these herds, milk yield losses attributable to clinical mastitis may be greater than that associated with high SCC.[1] The primary mastitis pathogens are often environmental organisms such as *E. coli* and the environmental streptococci (*Strep uberis* and *Strep dysgalactia*).

This paper will review three primary cost centers attributable to mastitis and give individual farms a way to estimate and compare the profit opportunity of milk quality programs. A form adapted from work by Dr. Ken Nordlund will be introduced as a summary tool for on-farm use.[1]

Premiums

Most milk purchasers prefer to purchase milk with low SCC and offer financial incentives to farmers for high quality milk. High SCC milk is not desirable for processors because it reduces the shelf life of dairy products and diminishes the quality and quantity of milk protein, thereby reducing cheese yields. Even modest increases in individual cow SCC (>100,000/ml) have been shown to reduce cheese yields.[1] Quality premiums are a great opportunity for farmers to increase the marginal profit of their farms because they offer one of the few ways for farmers to significantly impact the price of milk that they receive. Farms that are not maximizing the opportunity that premiums offer may be missing an important source of income. There are 3 simple steps to calculate the potential opportunity from milk quality premiums (Table 1).

1 Nordlund, K. A form to develop goals for dairy production medicine programs. 1998. Proceedings of the Dairy Certificate Program, Jan 14-16, 1998. School of Vet Medicine, University of Wisconsin, Madison, WI. Used by permission of the author.

Table 1: Calculation of Milk Quality Premium Opportunity

	$ per cwt	
A. Maximum available SCC premium (at 100,000 to 150,000 cells/ml)		
B. Currently Received SCC Premium (last milk Check)		**Current Monthly Premium Opportunity**
Potential Premium Difference:	(A-B)	
C. Hundredweight's shipped last month:		**(A-B) x C =**

The first step is to determine the maximum available SCC premium (Box A). Some premium programs continue to offer incentives down to a SCC level that is unrealistic for many farms (<100,000 cells/ml). If so, maximum available premium that is offered at 100,000-150,000 SCC may be used. The premium that the farm received on the last milk check is entered in box B and the potential premium difference can be calculated by subtracting B from A. Finally, the number of hundredweight's shipped last month is multiplied by the potential premium difference to obtain the current monthly premium opportunity. An example using a 50-cow dairy shipping 106,750 lbs/month with a 450,000 cell count illustrates the process **(Table 2):**

Table 2: Example Calculation of Milk Quality Premium Opportunity

	$ per cwt	
A. Maximum available SCC premium (at 100,000)	$0.70	
B. Currently Received SCC Premium ($0.20 deduct at the last milk Check)	-0.20	**Current Monthly Premium Opportunity**
Potential Premium Difference:	$0.90	
C. Hundredweight's shipped last month:	1,068	**$961.00**

In this example, the 50-cow dairy was losing almost $1,000 per month in potential profit. Actual premium opportunity values from several Wisconsin farms are shown in **(Table 3):**

Table 3: Milk Quality Premium Opportunity from Several Wisconsin Dairy Farms

Farm	No. Cows	Milk Shipped	SCC	Monthly Premium Opportunity
1	40	75,000 lb	277,000	$ 338
2	76	150,000 lb	620,000	$1,500
3	112	210,000 lb	460,000	$2,520
4	390	860,000 lb	355,000	$4,558
5	665	1,336,000 lb	200,000	$3,206

Most of these farms can justify a considerable investment in milk quality programs, simply by the return of real dollars in quality premiums.

Production (subclinical mastitis)

Somatic cells in milk consist of white blood cells (WBC) and epithelial cells that are shed from the udder. When mastitis causing organisms infect the udder, the cow's immune system sends large number of WBC's to the udder to fight off the infection. The SCC in cows that do not develop mastitis is always less than 250,000 cells/ml. A SCC >250,000 indicates that the cow has a subclinical mastitis infection. The linear score (LS) is another way to measure SCC **(Table 4)**. Research has shown that the linear score is highly related to loss of milk production in infected cows **(Table 4)**.[5]

Table 4: Relationship between SCC, Linear Scores and Milk Yield Loss

SCC Midpoint (range)	Linear Score	Milk Loss for Lact 1	Milk Loss for Lact 2+
25,000 (18,000-34,000)	1	0	0
50,000 (35,000-68,000)	2	0	0
100,000 (69,000-136,000)	3	200 lb	400 lb
200,000 (137,000-273,000)	4	400 lb	800 lb
400,000 (274,000-546,000)	5	600 lb	1200 lb
800,000 (547,000-1,092,000)	6	800 lb	1600 lb
1,600,000 (1,093,000-2,185,000)	7	1,000 lb	2,000 lb

Milk production loss is the result of damage and chronic scarring of milk secretory tissue in the udder. Linear score data can be used to estimate milk production losses due to subclinical mastitis **(Table 5)**. The first step is to enter the number of

Table 5: Estimated Production Losses Due to Subclinical Mastitis

Lact. Group	Number of Cows	Avg. Linear Score	Goal	Est. Milk Loss/unit LS	Milk Lost per Group (lbs)	Monthly Production Losses due to Subclinical Mastitis
1			-2.0	X 200 lbs		
2+			-2.5	X 400 lbs		
Milk Price per lb:_____			X Total Lbs Lost:			÷12=

first lactation and later lactation animals that are currently milking and the corresponding average linear scores (found on DHIA sheets) for each of those groups. Milk loss is estimated based upon the principle that each increased unit of LS greater than the goal accrues an annual loss of 200 lbs (first lactation) or 400 lbs (later lactation). First, the LS goal is subtracted from the actual LS and multiplied by the estimated milk loss to determine the milk lost per group. The total milk loss is then summed, multiplied by the current milk price and divided by 12 to determine the monthly production loss that can be attributed to subclinical mastitis. An example using a 100-cow herd with 50 first lactation (average LS of 4.0) and 50 older cows (average LS of 5.5) is shown in Table 6. A milk price of $14.00/cwt is used in this example. The difference between the average LS for heifers and the goal is 2.0 units (4.0-2.0). Multiplying 50 X 2.0 units X 200 lbs equal 20,000 lbs lost. The older cow milk lost is estimated by: 50 X 2.5 units X 400 lbs = 50,000

lbs. Therefore the total milk lost is estimated to be 70,000 lbs. The milk price per pound ($0.14) is then multiplied by 70,000 and divided by 12 months to estimate a monthly value.

Table 6: Example Calculation of Production Losses dues to Subclinical Mastitis

Lact. Group	No Cows	Avg. Linear Score	Goal	Est. Milk Loss/unit LS	Milk Lost per Group (lbs)	Monthly Production Losses due to Subclinical Mastitis
1	50	4.0	-2.0	X 200 lbs	20,000	
2+	50	5.5	-2.5	X 400 lbs	50,000	
Milk Price per lb: $0.14 X			Total Lbs Lost:		70,000	÷12 = $816

Actual subclinical production loss values from several Wisconsin farms are shown in Table 7:

Table 7: Subclinical Production Losses from Several Wisconsin Dairy Farms

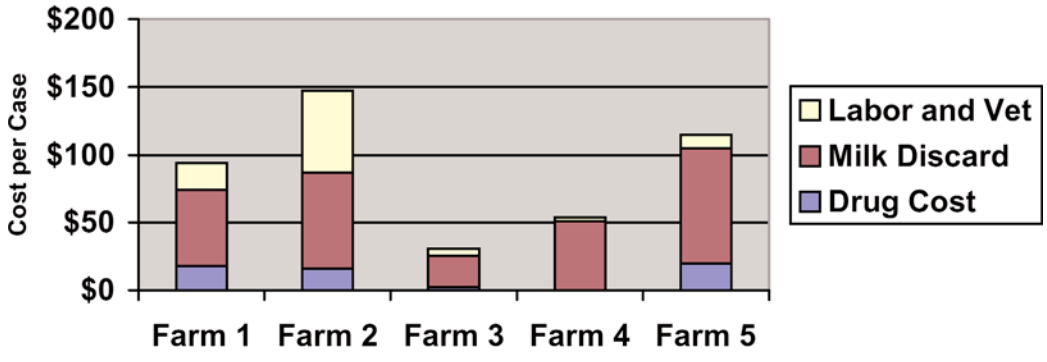
Farm	No. 1st Lact	No. 2+ Lact	Avg. LS Lact 1	Avg. LS Lact 2+	Estimated Production Losses due to Subclinical Mastitis
1	79	33	3.3	5.2	$ 915
2	56	107	2.7	3.1	$ 463
3	11	29	2.8	3.7	$ 212
4	34	80	2.8	4.0	$ 436
5	399	325	3.1	3.0	$2,280

Improvements in subclinical mastitis are not always as immediate or apparent as opportunities from quality premiums. However, it is apparent that considerable improvement in production is possible by limiting the number of subclinical mastitis infections.

Pails of Discarded Milk (clinical mastitis)

The final primary cost center for mastitis is financial losses attributable to clinical mastitis. The cost of clinical mastitis is often difficult to determine because the definition of a clinical case varies among milkers and between farms, treatment protocols vary and many farms do not routinely record the number of clinical cases that occur. The largest proportional cost of clinical cases is typically discarded milk **(Figure 3)**.

Figure 3: Estimated Partial Cost per Case of Clinical Mastitis on Several WI Dairy Farms



The calculations of losses attributable to clinical mastitis usually require making some rough estimates of some of the input values. More accurate cost accounting can be performed by actually collecting records of the input data required to compute costs. The first step is to enter the average cost of drugs (including oxytocin and fluid costs) used to treat a clinical case **(Table 8)**.

Table 8: Calculation of Cost of Clinical Mastitis

Average cost of drugs used (include all drug costs):		A
Avg. Number of days milk discarded:	B	
Avg. Prod/cow/day discarded:	C	
Milk price per lb:	D	
Total Cost of Discarded Milk:		(B x C x D)
Estimated Labor and vet costs/cow:		E
Total Cost per Clinical Case of Mastitis		**A + (BxCxD) + E**
Estimated Number Clinical Cases Treated per Month:		**F**
Monthly Cost of Clinical Mastitis:		**F x Total Cost**

Next the cost of discarded milk is calculated by multiplying the pounds of milk discarded by the milk price per lb (lines B, C and D). Estimated labor and veterinary costs are then added to determine the total cost per clinical case. Finally, to determine the total monthly loss, the number of clinical cases is multiplied by the cost per clinical case. An example with real farm data is shown in **(Table 9)**:

Table 9: Example Calculation of Cost of Clinical Mastitis

Average cost of drugs used (include all drug costs):		$18.00
Avg. Number of days milk discarded:	6	
Avg. Prod/cow/day discarded:	65 lbs	
Milk price per lb:	$0.145	
Total Cost of Discarded Milk:		$57.00
Estimated Labor and vet costs/cow:		$20.00
Total Cost per Clinical Case of Mastitis		**$95.00**
Estimated Number Clinical Cases Treated per Month:		**4**
Monthly Cost of Clinical Mastitis:		**$380**

On many dairies the cost of discarded milk can be a considerable, hidden cost of clinical mastitis. Cows that are chronically infected and treated repeatedly may contribute less milk to the bulk tank than to the drainage lagoon! Keeping records of the number of clinical mastitis cases and the number of days discarded can be important in optimizing profit.

Total Mastitis Losses

Lost premium opportunities, decreased milk production and discarded pails of milk are only a partial accounting of the total actual cost of mastitis on most dairy farms. Mastitis causes additional losses due to death, culling, decreased genetic

gain and reductions in reproductive efficiency. These additional costs are often difficult to quantify on an individual working farm. The computations given in this paper can be used in a partial budget format to determine where the best opportunity for return on investments in milk quality lie. It is also important to recognize that the old maxim "garbage in, garbage out" applies very much to these estimates. Accuracy of on-farm estimates of the financial opportunity related to milk quality will be greatly enhanced by on-farm records of clinical mastitis and monthly SCC testing.

APPENDIX 1:
FINANCIAL OPPORTUNITY ASSOCIATED WITH MILK QUALITY

Monthly opportunity from Premiums:

	$ per cwt	
C. Maximum available SCC premium (at 100,000 to 150,000 cells/ml)		
D. Currently Received SCC Premium (last milk Check)		**Current Monthly Premium Opportunity**
Potential Premium Difference:		
C. Hundredweight's shipped last month:		

Monthly Losses Attributable to Subclinical Mastitis

Lact. Group	Number of Cows	Avg. Linear Score	Goal	Est. Milk Loss/unit LS	Milk Lost per Group (lbs)	Monthly Production Losses due to Subclinical Mastitis
1			-2.0	X 200 lbs		
2+			-2.5	X 400 lbs		
Milk Price per lb:_____ X Total Lbs Lost:						÷12=

Monthly Losses Due to Clinical Mastitis:

Average cost of drugs used (include all drug costs):		A
Avg. Number of days milk discarded:	B	
Avg. Prod/cow/day discarded:	C	
Milk price per lb:	D	
Total Cost of Discarded Milk:		(B x C x D)
Estimated Labor and vet costs/cow:		E
Total Cost per Clinical Case of Mastitis		**A + (BxCxD) + E**
Estimated Number Clinical Cases Treated per Month:		**F**
Monthly Cost of Clinical Mastitis:		**F x Total Cost**

References

1. Barbano, DM, Rasmussen RR, and Lynch JM. 1991. Influence of milk SCC and milk age on cheese yield. J Dairy Sci 74:369-388.
2. Deluyker, HA, Gay JM., and Weaver, LD. 1993. Interrelations of somatic cell count, mastitis and milk yield in a low somatic cell count herd. J Dairy Sci 76:3445-3452.
3. Lam, T.J.G.M., Berkem, H.W., Dopfer, et al.. 1997. Usefulness of recording clinical mastitis episodes. PP 113-118 in Proceedings of the 36th annual meeting of National Mastitis Council, Albuquerque NM. Natl. Mast Coun. Madison WI.
4. Ott, S. Costs of herd-level production losses associated with subclinical mastitis in US Dairy Cows. 1999. PP 152-156 in Proceedings of the 38th annual meeting of National Mastitis Council, Arlington VA. Natl. Mast Coun. Madison WI.
5. Raubertas, RF and Shook, GE. 1982. Relationship between lactation measures of somatic cell concentration and milk yield. J Dairy Sci. 65:419
6. White GC. Couture, GW., Anderson EO et al, 1937. Chronic bovine mastitis and milk yield. J Dairy Sci 20:171-180.

RESOURCES MILK MONEY

Evaluating the Effectiveness of Mastitis Vaccines

Pamela Ruegg, DVM, MPVM
University of Wisconsin – Madison

Introduction

Mastitis control is based upon adoption of preventive control strategies including good milking hygiene, the use of properly functioning milking equipment, provision of clean and dry housing areas, sound nutritional programs and proper identification and treatment of cows that are infected with subclinical and clinical mastitis. Worldwide, many dairy farmers have adopted these procedures and produce high quality milk. However, mastitis remains the most common and costly disease of dairy cattle and many producers continue to struggle to achieve their quality goals.

Mastitis results when pathogenic bacteria are able to gain entrance to the udder, overcome the cows' immune defenses, establish an infection and produce inflammation of udder secretory tissue.

The use of vaccination to control infectious diseases in dairy cattle is common and vaccination against mastitis pathogens is a control strategy used by some dairy farmers. Research on mastitis vaccines has been conducted for at least 30 years and several mastitis vaccines are commercially available.

The objective of this paper is to review current concepts about vaccines used to control mastitis in dairy cattle.

Mastitis Vaccines

Commercial mastitis vaccines are currently available in the United States for immunization against mastitis caused by *Staphylococcus aureus* and *E. coli*. There are two *Staph aureus* bacterins marketed to U.S. dairy producers but they are simply separate licensures of the same product.

The vaccines are marketed as Somato-Staph® and Lysigin® and are labeled as somatic antigen containing phage types I, II, III, IV and miscellaneous groups of *Staph aureus*. There are three coliform mastitis vaccines marketed but two of the products are identical. The two identical coliform bacterins are marketed as J-5 Bacterin and Mastiguard.™ A separate bacterin-toxoid (J Vac®) is also available. A 4th gram negative mastitis vaccine (Endovac-Bovi®) contains re-17 mutant Salmonella typhimurium bacterin toxoid. All coliform mastitis vaccine formulations use gram-negative core antigens to produce non-specific immunity directed against endotoxic disease.

Effective immunization against mastitis has been a goal of mastitis researchers for many years. Several authors have reviewed the problems associated with vaccination against mastitis.[2,11,18] The nature of the disease creates a number of unique challenges for the production of successful immunity against mastitis.[18] Mastitis is defined as inflammation of the mammary gland, yet the purpose of vac-

cination is to enhance the immune response. In the case of mastitis, an enhanced immune response is not always considered beneficial.

One component of the immune response is the migration of large numbers of white blood cells (in the udder called somatic cells) to the infected gland. The presence of somatic cells in the milk is not considered a positive outcome as somatic cells are evidence of mastitis and reduce milk quality. Effective immunization is difficult because of the very nature of milk.[18]

The volume of milk present in the gland dilutes the number of immune cells available to fight infection and milk components such as fat and casein reduce the bactericidal abilities of the infection- fighting immune cells. Additionally, the cow is exposed to numerous organisms that have the potential to cause mastitis and milk is an excellent substrate for bacterial growth.

The definition of a successful mastitis vaccine may vary depending upon the herd situation. Farmers may expect mastitis vaccines to reduce the severity and frequency of mastitis, prevent new infections and eliminate existing infections.[18] While these expectations seem reasonable, it is unlikely that any one vaccine will be able to achieve all of these outcomes. Furthermore, the evaluation of mastitis vaccines is complicated by the underlying biology of the various mastitis pathogens.

One of the most frustrating mastitis pathogens is *Staph aureus*. This organism is a highly successful mastitis pathogen in that it has evolved to produce infections of long duration with limited clinical signs. Most infections with this pathogen are subclinical in nature and are detected by the production of poor quality milk. While clinical mastitis may occur sporadically, affected animals rarely become seriously ill and the major economic effect of this disease is reduced milk yield and quality premiums received by the producer.

Animals are at risk for this organism throughout lactation and often becoming infected after prolonged periods of exposure. Unless a vaccine can prevent new infections throughout lactation and dramatically reduce the SCC of affected animals, it may be difficult for a producer to recognize the benefit of using a *Staph aureus* vaccine.

In contrast, mastitis caused by coliforms (*E. coli, Klebsiella spp*. and others) is usually of short duration and <15% of affected animals usually develop chronic infections. Coliform mastitis is generally clinical in nature and many affected animals exhibit systemic signs of disease.

The clinical symptoms associated with coliform infections are the result of endotoxin released from the cell wall of dying gram-negative bacteria. There is rarely a long-term impact of coliform infections on SCC. Losses attributable to coliform mastitis are associated with the clinical episode and are the result of reduced milk yield, discarded milk, treatment costs, death and culling.

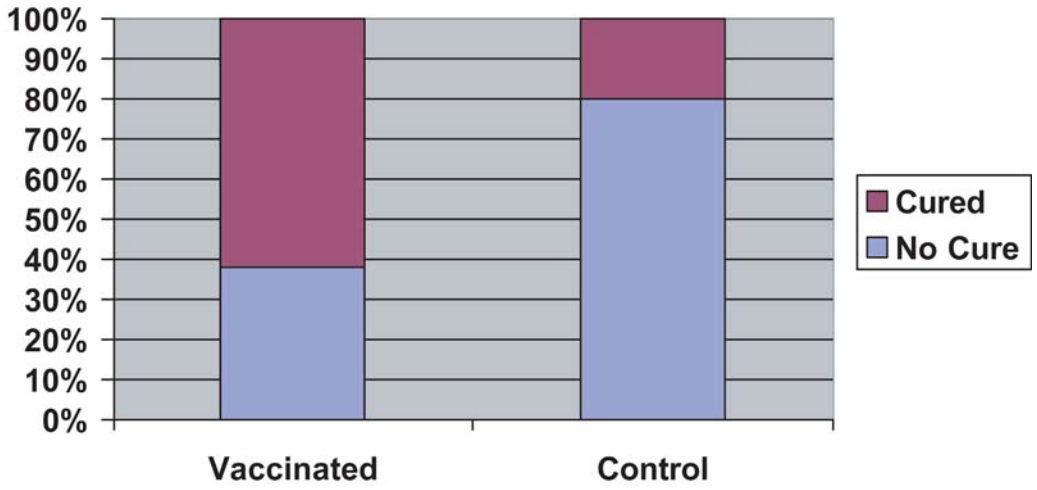
The highest risk period for coliform mastitis is during the immediate periparturient period. Therefore, a vaccine may be judged effective if it successfully reduces symptoms of coliform mastitis during this limited “at-risk” period.

Assessing Vaccine Efficacy

Staph aureus Vaccines

It is generally accepted that commercially available *Staph aureus* vaccines have limited ability to prevent new infections.[11,18] A 3-lactation trial failed to demonstrate a reduction in the number of new *Staph aureus* infections in cows vaccinated with a commercial vaccine.[14] This study did document an increase in the spontaneous cure rate of cows that received the vaccine. Similar results were found in a separate study conducted in 3 commercial dairy herds in New Zealand (Figure 1).[13]

Figure 1. Spontaneous Cure Rate

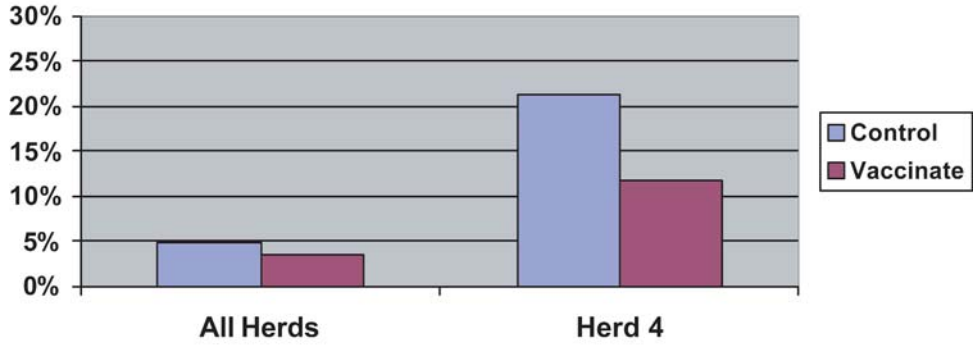


There are several other studies that support the ability of commercially available *Staph aureus* vaccines to enhance spontaneous cure rates. Literature published by representatives of the manufacturer suggests that the best use of this vaccine is the reduction of chronic infections rather than prevention of new infections.[17] The ability of commercial *Staph aureus* vaccines to reduce the development of chronic infections may be useful in some herds that are involved in *Staph aureus* control programs, but for most herds the successful control of *Staph aureus* mastitis will result from the prevention of new infections. The failure to prevent new infections is probably the reason that this vaccine is used on a limited basis in mastitis control programs.

There have been several approaches to the development of experimental vaccines directed toward the control of *Staph aureus* mastitis. Researchers have attempted to develop vaccines directed toward specific virulence factors responsible for the development of mastitis. Vaccines have been formulated based on bacterial cell wall components (protein A), adhesion factors (bacterial factors that allow Staph aureus to attach to mammary epithelial cells) and *Staph aureus* pseudocapsules (a slime layer that surrounds the bacteria and reduces the ability of WBC to destroy the bacteria). The outcomes of these studies have been inconsistent and confusing to interpret.

Australian researchers have published several papers describing results of vaccine trials using an inactivated vaccine produced from *Staph aureus* strains that produce pseudocapsules.[15,16] An experimental challenge study documented that this vaccine can successfully stimulate the development of anti-pseudocapsule antibody and reduce the development of clinical symptoms.[15] The vaccine did not significantly reduce SCC or increase milk yields of infected cows. This particular vaccine was further evaluated in a 7-herd field study.[16] The results of this study were interesting because there was no significant effect of vaccination on SCC or clinical mastitis when data from all 7-herds were included in the analysis. However, this study did demonstrate that differences were seen between herds (Figure 2).

Figure 2. Clinical Mastitis Caused by Staph aureus

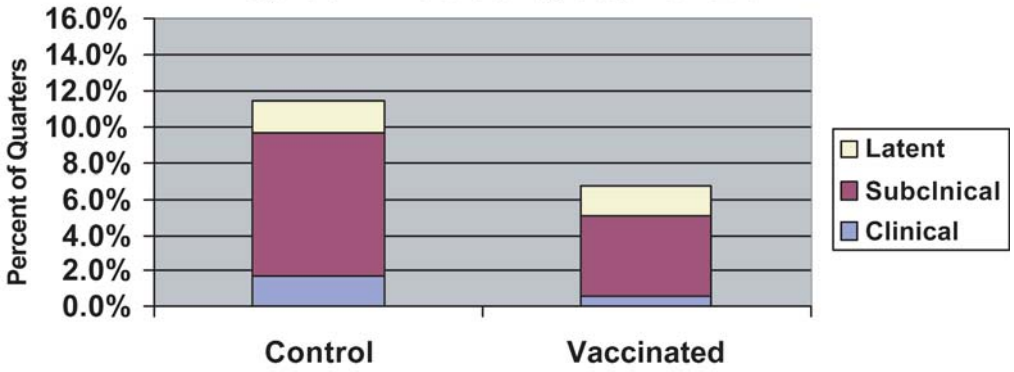


When analysis was restricted to a single herd that had a high prevalence of *Staph aureus* mastitis, the vaccinated animals had a reduction in signs of clinical mastitis and reduced development of new subclinical mastitis infections.

A Norwegian researcher enrolled 108 heifers from 16 farms in a study of a vaccine that included pseudocapsule and toxoids.[12] Almost 20% of the cows in the enrolled herds were infected with *Staph aureus* mastitis. Vaccination did not significantly affect the rate of clinical mastitis or the SCC of enrolled cows. Vaccination did seem to lessen the development of clinical mastitis from subclinically infected cows.

A vaccine consisting of inactivated, highly encapsulated *Staph aureus*, unencapsulated *Staph aureus* and exopolysaccharides has been developed and tested in Argentina.[3,6] The field trial portion of the studies was conducted in dairy herds with poor milk quality and a moderate prevalence of existing *Staph aureus* infections.[3] The experimental unit was quarters and the researchers excluded quarters that were infected prior to beginning the study. Under these conditions, the vaccine successfully reduced new intramammary infections with *Staph aureus* (Figure 3) but did not significantly affect the SCC.

Figure 3. IMI Caused by Staph aureus



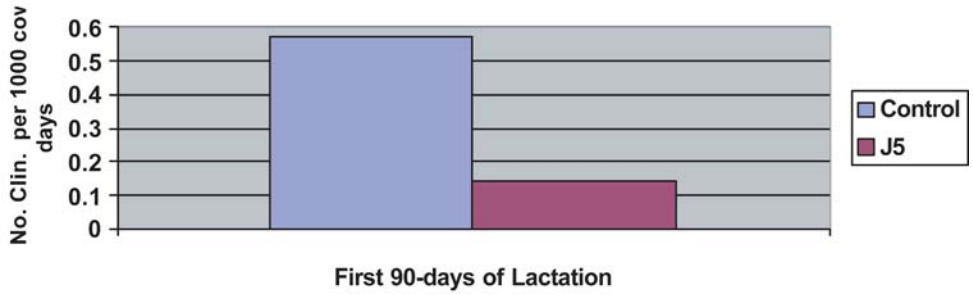
In general, there seems to be progress in the development of an effective *Staph aureus* vaccine but the efficacy of these vaccines seems to vary by herd. The greatest effect of *Staph aureus* vaccines appears to be a decrease in the development of clinical symptoms and preventive management programs are needed to effectively reduce the new infection rate.

Coliform Vaccines

The use of vaccines against gram-negative bacterial mastitis ("J5 vaccines") has become standard practice on many dairy farms in the United States. The efficacy of these vaccines has been demonstrated in both experimental challenge trials and in field trials in commercial dairy herds.[7,8,9] The biologic principle of these bacterins is based upon their ability to stimulate production of antibodies directed against common core antigens that gram-negative bacteria share. These vaccines are considered efficacious even though the rate of intramammary infection is not significantly reduced in vaccinated animals because they significantly reduce the clinical effects of the infection. Experimental challenge studies have demonstrated that J5 vaccines are able to reduce bacterial counts in milk and result in fewer clinical symptoms.[8] The prevailing theory is that J5 vaccines enhance the ability of WBC to destroy the bacteria.

Vaccinated cows therefore may become infected with gram-negative mastitis pathogens at the same rate as control animals but have a lower rate of development of clinical mastitis (Figure 4).[7]

Figure 4. Rate of gram-negative Clinical Mastitis



Researchers have also demonstrated that vaccination with J5 bacterins reduced the duration of IMI from 130 hours in control animals to 80 hours in animals that received the vaccine.[9] The use of J5 vaccines has been justified in several economic models because of reduced production, culling and death losses.[1,4] The significant economic benefit from the use of these vaccines has resulted in mastitis consultants recommending their use in most dairy herds.

Other vaccines

The increased frequency of mastitis caused by environmental streptococci has resulted in a number of attempts to produce vaccines against these pathogens. There has been a sustained, focused research effort for vaccines directed against *Streptococcus uberis*.[10] Repeated immunization with a killed *S. uberis* vaccine was effective in reducing the number of bacteria in milk from animals that were experimentally challenged with the same strain of *S. uberis*.[5] Immunization did not reduce the SCC level in this study. One strain each of *Streptococcus uberis* and *Streptococcus agalactia* were included in an experimental multivalent killed mastitis bacterin that was tested in a field trial.[3,6] This vaccine had no significant effect on the occurrence of mastitis caused by Streptococcus organisms but the study may not have been designed with enough power to be able to detect a difference if one did exist. Researchers have also investigated live vaccines against *Strep uberis* but have concluded that the strain-specific nature of protection obtained will limit the applicability of live antigen vaccines.[10] At this time, there are no commercial vaccines available that protect against Streptococcus mastitis.

Current Recommendations

In most herds the most effective control strategy is prevention of new infections by the use of good management practices. The use of *Staph aureus* vaccines is not universally recommended but may be useful in some herds as an adjunct to prevention oriented control programs. J5 vaccines are economically viable for many dairy herds.

The manufacturer of J-Vac© has created a partial budget program that can be used to perform a cost to benefit analysis for herds at various levels of milk price, mastitis incidence and milk yield. A key assumption of this model is that E. coli causes 10% reduction in milk yield and that the vaccine efficacy is 80%.

It is also important to emphasize that vaccines must be handled properly, used before the expiration date and given to healthy immune competent cattle in the manner recommended by the manufacturer.

References

1. Allore HG, Erb HN. 1998. Partial budget of discounted annual benefit of mastitiscontrol strategies. J Dairy Sci 81:2280-2292.

2. Anderson JC, 1978. The problem of immunization against staphylococcal mastitis. British Vet J. 132:412 – 420.

3. Calzolari A, Giraudo JA, Rampone H, Odierno L., et al. 1997. Field trials of a vaccine against bovine mastitis. 2. Evaluation in two commercial dairy herds. J Dairy Sci. 80:854-858.

4. Degraves FJ, Fetrow J. 1991. Partial budget analysis of vaccinating dairy cattle against coliforms mastitis with an Escherichia coli J5 vaccine. J Am Vet Med Assoc. 199:451- 455.

5. Finch JM, Hill AW, Field TR, Leigh JA. 1994. Local vaccination with killed Streptococcus uberis protects the bovine mammary gland from experimental infection following intramammary challenge with the same strain. Inf Imm, 62:3599-3603.

6. Giraudo, JA, Calzolari A., Rampone H, Rampone A., et al. 1997. Field trials of a vaccine against bovine mastitis. 1. evaluation in heifers. J Dairy Sci 80:845-853.

7. Hogan JS, Smith KL, Todhunter DA, Schoenberger PS. 1992. Field trial to determine efficacy of an Escherichia coli J5 mastitis vaccine. J Dairy Sci 75:78-84.

8. Hogan JS, Weiss WP, Todhunter DA, et al. 1992. Efficacy of an Escherichia coli J5 mastitis vaccines in an experimental challenge trial. J Dairy Sci 75:415-422.

9. Hogan JS, Weiss WP, Smith KL, Todhunter DA, Schoenberger PS. 1995. Effects of an Escherichia coli J5 vaccine on milked clinical coliforms mastitis. J Dairy Sci 78:285- 290.

10. Leigh JA. 1999. Streptococcus uberis: a permanent barrier to the control of bovine mastitis? Vet J 157:225-238.

11. Nickerson SC. 1999. Role of vaccination and treatment programs. Pp 76 - 85 in Proc. 38th Ann. Mtg. Natl. Mastitis Council, Arlington VA. Natl. Mastitis Counc., Inc., Madison, WI.

12. Nordhaug ML, Nesse LL, Norcross NL, Gudding R. 1994. A field trial with an experimental vaccine against Staphylococcus aureus mastitis in cattle. 1. Clinical Parameters. J Dairy Sci 77:1267-1275.

13. Pankey JW, Duris G., Murray G. Twomey A. 1983. Evaluation of a commercial bacterin against Staphylococcus aureus mastitis in New Zealand. Pp 157 – 161 in Dairy Res. Rep. 1983, Hill Farm Res. Stn., Homer LA.

14. Pankey JW, Boddie NT, Watts JL, Nickerson SC. 1985. Evaluation of protein A and a commercial bacterin as vaccines against Staphylococcus aureus mastitis by experimental challenge. J dairy Sci 68:726-731.

15. Watson DL. 1992. Vaccination against experimental staphylococcal mastitis in dairy heifers. Res Vet Sci 53:346-353.

16. Watson DL, McColl ML, Davies HI. 1996. Field trial of a staphylococcal mastitis vaccine in dairy herds: clinical, subclinical and microbiological assessments. Aust Vet J 74:447-450.

17. Widel PW. 1994. What about Staphylococcus aureus vaccine? Agri-Practice 15:26-28.

18. Yancey RJ. 1993. Recent advances in bovine vaccine technology. J dairy Sci 76:2418- 2436.

TROUBLESHOOTING HIGH BACTERIA COUNTS IN FARM MILK

Douglas J. Reinemann, Graeme A. Mein,
David R. Bray, David Reid, and Jenks S. Britt

Sources of Bacterial Contamination in Raw Milk

The two main sources of bacteria in raw milk are mastitis organisms from within the udder and organisms transported from the environment on the surface of the teats. Bacteria deposited in the milking and milk handling equipment will multiply and become a major source of contamination if this equipment is not cleaned and sanitized properly. Cleaning of milk handling equipment is accomplished by a combination of chemical, thermal and physical processes. A cleaning failure can result from a failure in any one of these processes.

This procedure is designed to help dairy producers and service personnel identify sources and resolve high bacteria count problems in raw milk. The methods presented deal primarily with the diagnosis of problems relating to pre-milking cow sanitation and milking equipment cleaning and incubation. Methods for diagnosis and treatment of mastitis problems are covered in detail in other publications.

The accompanying form is to be used as an aid in diagnosis and problem solving. It is not intended that the entire procedure will be implemented whenever a high bacteria problem is encountered. The procedure is intended to begin with simple routine testing and provide recommendations to proceed in a logical fashion to the more difficult and comprehensive testing based on test results and interpretation.

Routine Bulk Tank Testing (Part 1a)

Some form of testing for bacterial contamination is done periodically on all farms to assure compliance with national, state and local milk plant requirements. These tests usually include the Somatic Cell Count (SCC), Standard Plate Count (SPC) and may also include the Preliminary Incubation count (PI) or other tests. These tests provide an overall measure of milk quality but they have little diagnostic value in determining the source of bacterial contamination. If a routine bulk tank sample indicates a bacteria problem (high SPC or PI), the first step in determining the cause of the problem is to perform a more thorough analysis of bulk tank milk. Routine bulk tank evaluation can be used to assess the types and levels of mastitis in a herd, the practices of the milkers, and the effectiveness of equipment cleaning and sanitation.

Methods for routine bulk tank culture analysis have been presented by Guterbach and Blackmer (1984). These methods have been adopted by a number

of progressive milk processors. These tests and interpretation methods provide an indication of whether high bacterial counts are due to mastitis, pre-milking hygiene, equipment cleaning and sanitation, or incubation of bacteria in the milk handling system during milking. This is invaluable information to the dairy producer and processor. The recommended tests include:

Standard Plate Count (SPC): The Standard Plate Count is the number of colony forming units in one ml of milk when incubated for 48 hours at 32 C (90 F). The SPC should be less 5000 if cow and equipment sanitation is good and cooling is adequate. A SPC of less than 1000 indicates excellence in all of these areas. Most industry standards require a SPC of less than 50,000.

High bacteria counts may result from *Strep. ag*. mastitis infection in the herd. If the SCC and SPC are both high, a thorough bulk tank culture should be performed to determine the type of mastitis organisms present in the milk. This information is useful to manage mastitis in the herd. Other types of bacteria represent contamination from the environment. These organisms are transported during milking from the skin of the udder into the milk and onto milk handling equipment. These bacteria multiply during the milking process and may continue to multiply between milkings if they are not removed or killed.

Lab Pasteurized Count (LPC): The Lab Pasteurized Count is the number of bacteria per ml of milk which survive laboratory pasteurization at 62.8 C (143 F) for 30 minutes. This procedure kills the usual mastitis-causing bacteria leaving only those organisms from the environment which can survive elevated temperatures. These types of organisms will grow and multiply in the milk handling equipment if cleaning and sanitation procedures are inadequate. The LPC should be below 100 to 200 if equipment cleaning and sanitation are good. A LPC below 10 indicates excellent equipment hygiene.

Coliform (Coli): The major source of coliform bacteria in bulk tank milk is transportation on the udders of cows from the environment. The Coli count thus provides an indication of both the effectiveness of cow preparation procedures during milking and the cleanliness of the cows' environment. Coliform counts between 100 and 1000 are generally an indication of poor milking hygiene. Coliforms will also incubate in residual films left on milk contact surfaces. Coliform counts in excess of 1000 suggest incubation in milk handling equipment. A Coli count less than 100 per ml of milk is considered acceptable for raw milk for pasteurization. In states where raw milk may be sold to consumers, Coliform count must be less than 10/ml. Coli counts less than 10 indicate excellence in both pre-milking hygiene and equipment sanitation.

Another test which indicates the cleanliness of cows when they are being milked is

the sediment in the bulk tank milk. A sediment level less than 1.50 mg per gallon is considered acceptable.

It is particularly important to exercise care in the collection and storage of samples for these tests. Samples should be taken so that they are not contaminated and stored below 40 F or frozen until processed. It is not advisable to perform diagnosis based on a single test. A series of at least three tests should be performed. For those producers concerned with producing quality milk, the entire series of tests should be performed weekly on large farms and at least monthly on small farms. These tests can help to quickly resolve crisis situations and, for the quality-conscious producer, can also provide valuable information to assess the relative performance of different pre-milking cow preparation methods and different equipment cleaning and sanitation regimes.

Strategic Milk Sampling (Part 1b)

When the routine bulk tank testing indicates that a problem exists, more detailed tests can be performed to further isolate the source of the problem and recommend the most expedient and effective methods to solve it. If the bulk tank analysis in part 1a indicates that equipment sanitation or incubation is the major source of bacteria, proceed with strategic milk sampling to further identify the source.

Strategic sampling of milk at different times during the milking process will determine if incubation in the milk handling system is a major source of contamination. Strategic sampling of milk in different locations will determine if the location of a cleaning failure and/or incubation problem is:

1) in the milking units, milkline and receiver,
2) in the milk transfer line (including filters and pre-ccolers)
3) or in the bulk tank

Observation of CIP Procedures (Part 2a)

If milk quality testing in part 1 indicates that there may be equipment cleaning problems proceed to part 2 to identify the specific cause of a cleaning and sanitation failure. Concentrate on those parts of the system indicated by strategic milk sampling.

A standard part of the assessment of any cleaning regime is to document the "as found" and "as practiced" conditions. The purpose of part 2a is to determine if the recommended CIP procedures are being followed correctly. Every milking system should have a set of written instructions for the CIP process. This should include the recommended cycles with the time, temperature and chemical concen-

tration specified for each cycle. If these instructions have not been provided by the equipment and chemical consultant, this part of the form can be used to provide them. Make sure that all personnel are aware of, and trained in, the recommended CIP procedures. Different hardware and procedures are usually used for cleaning the milking machine and the bulk milk storage tank.

It is advisable to observe one complete cleaning to document the cycles which are used and obtain the best information available as to the frequency of application of each cycle. The temperature of the water returning to the wash sink should also be recorded at the beginning and end of each cycle. Cleaning cycles are sometimes missed either as a routine practice or to save time when things get busy. Newer automatic washers can record whether cleaning cycles actually occurred and the temperature of each cycle. There are four parts to most cleaning regimes used in the U.S.:

1. An initial rinse is performed immediately after milking is completed, to remove most of the residual milk remaining in the system. The temperature of this rinse should be between 95 and 130 F. The upper limit has been specified in the belief that proteins may be 'baked' on to surfaces. The lower limit is set above the melting point of butterfat to ensure that fats will be removed and not redeposited. A benefit of increasing the rinse temperature is to reduce the temperature drop during the subsequent detergent wash cycle. If temperature drop during the detergent cycle is a problem, consider increasing the rinse temperature to the upper end of this limit.

2. A detergent wash cycle, usually with a chlorinated, alkaline detergent, is performed to remove organic soils such as milk fat and proteins. Consult the label instructions to assess whether 'as found' practices fall within these recommendations. Most detergents have a working temperature range between 110 F and 170 F which should be specified on the label. If organic films are present, consider raising the temperature to the upper limit of this range. Cleaning effectiveness improves as temperature is increased. Detergent concentrations may need to be adjusted to account for water hardness. This information should also be indicated on the product label.

3. An acid rinse cycle may be performed to remove mineral deposits from milk and hard water. The low pH environment created by the acid rinse also inhibits growth of bacteria during the time the milking equipment is not in use. This may be a cold or warm rinse. The recommended concentration and temperature should be specified on the product label.

4. A sanitizing cycle is performed immediately before milking, usually with a chlorine-based product. This is to kill any bacteria in the milking system which

have survived the cleaning process. Recommended temperatures are typically 95 - 110 F and should be noted on the product label.

It is the responsibility of the chemical consultant to prescribe the amount of chemical and temperature to be used for each cycle based on the water volume and results of water quality tests. The chemical consultant should be trained and equipped to perform water quality tests, measure water temperatures and volumes and determine if the appropriate chemicals are being used.

Shock Treatment: Some systems use "shock" treatments periodically to reduce bacteria counts. This procedure is commonly performed using higher than usual concentration of chemicals. Shock treatments shorten the life of equipment. They are also expensive and dangerous and do not correct the source of the problem. Shock treatments should not be required if the cleaning system is operating properly.

Residual Films: Cleaning failures usually result in a visual buildup or residual film on some part of the milk harvesting or storage equipment. Some of these films have a characteristic appearance which, if identified, can help determine the cause for the cleaning failure. There are two broad categories of residual films: Organic films such as fat and protein, and inorganic films such as hard water minerals, iron, and silica. Discoloration may also occur due to corrosion and/or pitting of surfaces. Protein films can appear as a brownish slime (applesauce) when wet. Mineral films usually have a rough porous texture and are invisible when wet. Organic films are generally alkaline soluble whereas inorganic films are generally acid soluble. Films can be diagnosed by scrubbing a small area with concentrated acid or with alkaline detergent solutions.

Drainage: Improper drainage is a common source of bacterial contamination. All parts of the milking system (both sanitary and non sanitary) should drain when the system is shut off. The milking system should be inspected for any pipes, hoses, fittings and equipment that do not drain when the system is shut off.

Other Parts of the System: The 'non-sanitary' parts of the milking machine may also be a source of bacterial contamination. If milk quality tests indicate an equipment cleaning and sanitation problem in the milking machine and the source cannot be found in the milking units, hoses, milkline or receiver, a visual inspection of pulsator and other airlines or ancillary equipment such as backflush systems should be performed. These non-sanitary parts of the system should be cleaned periodically as part of routine maintenance of the system. The seals and gaskets should be changed regularly to avoid contamination of these parts of the system.

Milk Temperature: The temperature of the milk at various points in the system will help determine if the cooling system is operating correctly. Inadequate cooling will increase bacteria counts by allowing a better environment for bacteria growth during storage. Milk should be cooled to 4.4 C (40 F) or below within 30 minutes of milking and held between 0 and 4.4 C (32 and 40 F) until pasteurized. If milk is not mixed adequately in the storage tank, temperature stratification may occur and reduce the effective cooling of the upper layers of milk.

Observation of CIP Flow Dynamics (Part 2b)

A cleaning failure will result if cleaning solutions are not adequately distributed to all parts of the milking system. If little or no cleaning solution comes into contact with any milk contact surface the chemical and thermal actions cannot take place. Part 2b is an initial assessment of the water and air flow dynamics of a milking CIP system. These observations and measurements can be performed without special test equipment (vacuum recorder, vacuum gauge and airflow meter). These observations should be performed if milk quality tests indicate a cleaning problem in the milking machine and all cleaning cycles have been observed to be executed properly.

The first step in assessing flow dynamics is to understand the intended flow circuit. A sketch of the CIP system will aid in understanding the flow circuit as well as document conditions for future reference and consultation with equipment service personnel. The sketch should indicate the diameter and length of all lines and location of critical components such as receiver(s), wash sink(s), air injector(s), wash valve(s) and any other ancillary equipment that is cleaned or used for cleaning. Document the location of any manual or automatic valves which may be operated before or during the wash cycle, whether air is being drawn in at the wash sink, and the timing of the air injector.

Flow problems commonly result from improper air injector location and/or timing cycles. This can be a problem in both Round-the-Barn (RTB), highline systems and milking parlors. The usual result is a flooded system. Some symptoms of improper air injector location and/or timing are:

1. The water level in the receiver does not change during the cleaning cycle
2. The milk pump never shuts off during the cleaning cycle.
3. The system 'traps out' (the ball valve in the sanitary trap shuts off system vacuum during one or more wash cycles)
4. A large volume of water drains from the distribution tank when the vacuum pump is shut off after cleaning.
5. Air is drawn in to the system at the wash sink. When air is drawn into water draw lines or milking units at the wash sink, the system has an uncontrolled point of air injection.

If these initial tests indicate that a flow problem may exist, a complete flow evaluation should be performed. Changes to the CIP system, such as changing air injector timing or changing any hardware, should not be done without the proper test equipment to properly assess their effects. A qualified service person with appropriate test equipment and training should be consulted for a complete flow analysis (Parts 3, 4 and 5). The installation and commissioning of every milking system should include installation of the equipment and adjustment of the controls to circulate solutions throughout the milking system for effective cleaning. A complete CIP flow analysis should be conducted whenever:

A new system is installed,

A change is made to an existing system, or

Milk quality tests indicate a cleaning problem and the recommended CIP procedures are being followed.

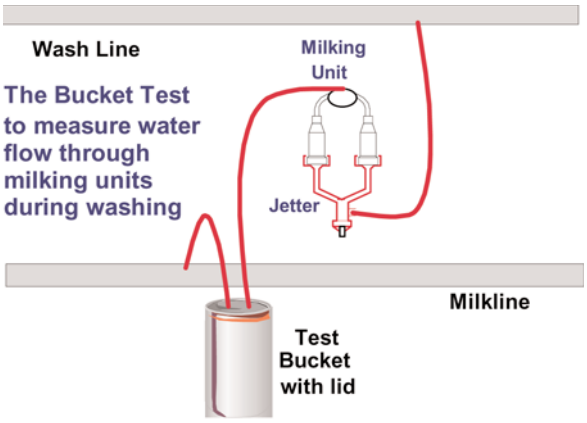
Water Quantity and Quality (Part 3)

Air drawn into the milking units or draw lines at the wash sink may be caused by flooding of the milking system (usually a result of improper air injection) or because of inadequate water volume. The minimum water volume required for proper flow dynamics can be estimated using the table in part 3. This table can be used to determine if the minimum water volume is available for each wash cycle and to determine if water and chemical costs can be reduced by improving the flow dynamics of the CIP system.

Cleaning chemical concentration may need to be adjusted for hard water. Record the water hardness to determine if the chemical concentrations are appropriate.

Unit Flow In Milking Parlors (Part 4)

A common problem in milking parlor systems is uneven distribution of water to the milking units. Visual indicators of low flow in a milking unit/jetter combination include: Reverse flow in jetter hoses, and Milking unit claw never floods during cleaning cycle. The flow rate through milking units and milk meters can be measured using the method illustrated here. Document the flow in the first, last and middle units and any units that appear dirty. Parlors should ideally



have uniform flow through all milking units. Preliminary results from field studies indicate that 0.8 gallons per minute (3 L/min) is sufficient to clean most milking units. While many units will clean at flow rates below 0.8 gpm (3 L/min), the risk of cleaning failure appears to be increased. Some milk meters may require water flow rates higher than 3 L/min for effective cleaning.

Flow restrictors should be installed at each jetter to balance the flow. Flow restrictors should not be placed in the washline feeding the jetters. Changing the flow rate to the milking units or milk meters may require an adjustment to the air injector timing and/or water volume required per cycle. Do not change either of these without consulting the service person and/or chemical consultant.

Milkline Slug Flow Dynamics (Part 5)

Proper test equipment is required to properly diagnose CIP circulation problems. Setup and troubleshooting of CIP flow dynamics should only be attempted by a qualified service technician with the proper test equipment. A vacuum recording device, commonly used to evaluate milking performance, is a essential test equipment to assess air injected slug flow during cleaning. More detail on diagnostic methods using a vacuum recorder for CIP analysis are given in the references. The following procedure has been developed to set air injector timing and diagnose faults.

1) Set air injector open time: The air injector open time is a relatively easy number to calculate and should be the first step in setup of an optimal cleaning cycle. The length of time that the air injector is open, together with slug velocity determine the travel distance of the slug. The slug formed at the point of air injection should travel to the receiver without breaking. Measure the distance that the slug must travel from the point of air injection to the receiver. Divide the slug travel distance by the desired slug velocity to determine the air injector open time. Use a value of 28 feet per second unless the system configuration would warrant a different speed. Slug velocity for optimal mechanical action is between 23 and 33 feet per second.

2) Check slug velocity and adjust air admission rate: Slug velocity should be measured using a vacuum recorder and the air admission rate adjusted to achieve the desired velocity. The rate at which air is drawn in through the air injector determines the travel speed of the slug. The physical connection to the milkline is best done with a tee inserted in-line with a milk hose near the milk inlet. Sections of transparent tubing 10 to 20 feet in length should be used to connect to the recorder. These tubes should be observed closely and bled often to prevent water from reaching the recorder. To minimize the risk of water entering the vacuum recorder, it is advisable to leave the hoses detached except when a measurement is being taken. Moisture traps will fill with water very quickly and are not recom-

mended. The following information can be gained from these vacuum recordings:

Slug Velocity: Slug velocity can be calculated by dividing the slug travel distance between the two measurement points by the time between vacuum drops. The tests points should be at least 30 feet apart for an accurate measurement.

Vacuum Drop: A rapid vacuum drop is measured when the slug passes the test points. The vacuum drop across a slug is a measure of the mechanical cleaning action produced. The recommended range of vacuum drop across the slug are given below. The vacuum drop should be near the maximum of the range at the beginning of slug travel. This vacuum drop across the slug will decrease slowly as it travels through the line due to slug decay and air entrainment.

Recommended range of vacuum drop across the slug.

Milkline Diameter	Vacuum Drop
2"	5.3 - 11 "Hg
2.5"	4.4 - 9.5 "Hg
3"	3.8 - 8.6 "Hg
4"	3.2 - 7.1 "Hg

Inadequate vacuum drop across the slug indicates that the slug is very short (less than 3 ft) and/or that excessive air is passing through the slug. A slow rate of vacuum drop indicates that the slug is moving slowly, usually because of excessive water in the pipeline or an excessively leaky milk/wash valve.

3) Set air injector closed (off) time: The amount of water drawn in during each cycle is determined by the amount of time the air injector is closed or off. If the sanitary trap is flooding or excessive water is being transferred through the trap, the closed time should be reduced. The closed time should be adjusted so the size of the slug reaching the receiver is just sufficient to wash the receiver. If the close time is reduced to the minimum value available on the controller and flooding still occurs, the capacity of the milk pump may need to be increased. Many parlors have an additional pipe to supply water to the milkline in addition to that supplied by the milking units. The water flow through these pipes should be restricted in most applications to avoid flooding the system. Independent control of water and air flow is required to achieve proper slug velocity and water draw rates.

4) Final vacuum recorder testing and unit flow tests. After the system has been adjusted according to steps 1 to 3, repeat vacuum recorder testing of slug flow. Check for the presence and strength of slug at the beginning, end and other critical locations in the milkline. Fine adjustment of the air injector should be performed at this time. The air injector should close just before the slug hits the receiver jar. If the air injector remains open after the main slug reaches the receiver, excessive water may be carried through the sanitary trap. After fine adjustment of the air injector, recheck unit flow at critical locations including the first, last, and middle units on both sides of the parlor, and on any units with visible buildup.

Sequenced Air Injection: For systems with more than one air injector, air injection should be sequenced so that both injectors are not open at once. Optimal air injector timing is usually different for wash manifolds than for the milk line. Sequenced air injection allows for optimization of both, thus improving cleaning action in the milking system as well as reducing vacuum pump requirements.

References

Bray, D.R., and J. K. Shearer, 1996. Trouble-Shooting a Mastitis Problem Herd. University of Florida Cooperative Extension Circular 1164.

Guterbach, W.M., and P.E. Blackmer, 1984. Veterinary Interpretation of Bulk Tank Milk. Veterinary Clinics of North America: Large Animal Practice, Vol. 6, No. 2, July 1984. Pp257-268.

Muljadi, A., D.J. Reinemann, and A.C.L. Wong, 1996. Air injected Clean-In-Place for Milking systems: Development of a Study Method and Characterization of Chemical, Mechanical and Thermal Factors. ASAE paper No. 963019. Written for Presentation at the 1996 International Meeting Sponsored by the American Society of Agricultural Engineers, July 14-18, 1996, Phoenix, AZ, USA

Peebles, R.W., and D.J. Reinemann, 1995. Control Strategies to Reduce the Vacuum Pump Capacity Required for Cleaning Milking Systems. Paper No. 953274, Written for Presentation at the 1995 International Meeting Sponsored by the American Society of Agricultural Engineers, June 18 23, 1995, Chicago, Illinois

Reinemann, D.J., 1995. System Design and Performance Testing for Cleaning Milking Systems. Proc. Designing a Modern Milking Center, Northeast Regional Agricultural Engineering Service National Conference, Rochester New York, Nov 29 - Dec. 1, 1995.

Reinemann, D.J. and R.W. Peebles, 1994. Flow Dynamics in Milking Parlor Clean-In-Place Systems. ASAE Paper No. 943567, Presented at the International Winter Meeting of the American Society of Agricultural Engineers, Atlanta, Georgia, December 13-16, 1994.

Reinemann, D.J. and J.M. Book, 1994. Airflow Requirements, Design Parameters and Troubleshooting for Cleaning Milking Systems. Proc. ASAE/NMC Dairy Housing Conference, 31 January- 4 Feb, 1994, Orlando Florida, USA.

Troubleshooting high bacteria counts in farm milk

General Information

Operator_____
Phone_____ Date_____
Address_____
Equipment Dealer_____
Phone_____
Chemical Supplier_____
Phone_____

Prioritized Recommendations

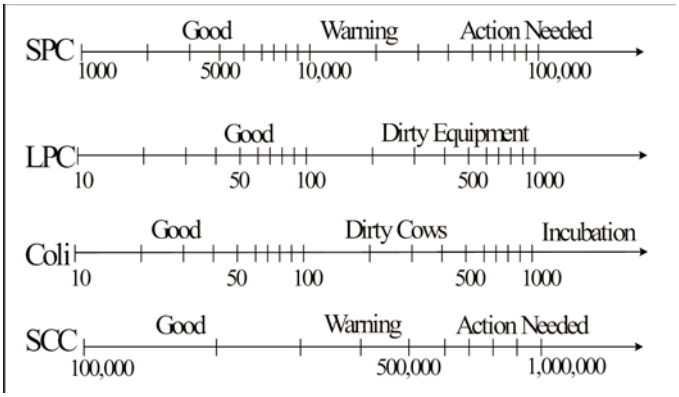
1._____
_____
2._____
_____
3._____
_____
4._____
_____

System Sketch

Part 1a — Routine Milk Quality Analysis

Bulk tank cultures can be used to diagnose equipment cleaning and sanitation problems, incubation of bacteria in the milk handling system during milking, inadequate pre-milking hygiene, and mastitis. Here is a list of goals and action levels for each type of test.

- Equipment cleaning and sanitation problems generally result in elevated LPC counts.
- Incubation of bacteria in the milking system cause elevated Coli (above 1000) and LPC counts.
- Inadequate premilking hygiene will result in elevated Coli counts (typically 100 to 1000) .
- If both SCC and SPC are high mastitis organisms may be the cause of high bacteria counts.



Composite milk samples should be taken from the bulk tank at the time the milk is shipped from the farm. The tests indicated above should be performed on a routine basis a minimum of monthly on small farms and weekly on large farms and more often if a problem situation exists. A minimum of three tests is needed to make a diagnosis. Record the culture results and test dates below:

Dates						
SPC: Standard Plate Count						
LPC: Lab Pasteurized Count						
Coli: Coliform Count						
SCC: Somatic Cell Count						

Part 1b — Strategic Sampling

If routine bulk tank analysis indicates that equipment cleaning and sanitation may be a problem it is desirable to further diagnose the source of the problem. Milk samples should be taken from the receiver(s), transfer line(s) and bulk tank after the first group of cows is milked (one cow for each milking unit) and after every 4 hours of milking (or since the system has been washed) with a final sample taken at the end of milking (or before the next wash cycle). Record the results of these tests in the following table.

SPC	After first group of cows	After 4 Hours	After 8 Hours	End of Milking
Time of Sample				
Receiver 1				
Receiver 2				
Transfer Line 1				
Transfer Line 2				
Bulk Tank 1				
Bulk Tank 2				

- Elevated counts in the receiver samples at the beginning of milking likely indicates a cleaning problem in the milking units, milk meters, milkline or hoses. If this situation exits perform the CIP flow analysis.
- Elevated counts in transfer lines but not in receiver after the first group of cows indicates cleaning failure in the transfer line and equipment between the receiver and bulk tank such as plate coolers and milk filters.
- A continual rise in counts during milking indicates incubation as the likely cause. Solutions to this problem may include washing the system more thoroughly and frequently or changing the milk filter more frequently.

Part 2a CIP Procedures Observations

Yes **No** Does the sanitary trap valve close (trapout) during the CIP procedure?

Yes **No** Is air drawn into units or wash lines at the wash sink?

Yes **No** Is the ball removed from the sanitary trap during washing?

Yes **No** Does more than 5 gallons of water drain from the balance tank after the wash cycle?

Yes **No** Does the milk pump run continuously during the wash cycle?

Yes **No** Is there any visible residue on system components?

Describe:

Location	Color	Texture	Acid Solution	Detergent Soluable	Chlorine Soluable

Yes **No** Is the system "shock" treated? **If yes**, how often? (note shock treatment dates on bulk tank culture records

_____

Yes **No** Do any system components fail to drain after CIP procedure?**If yes**, note which?

_____

Yes **No** Are any valves actuated manually before or during CIP procedure? **If yes**, note which_____

Milk Temperature:	Entering bulk tank_____ End of milking_____ At pickup:Top of tank_____ Bottom of tank_____				
	Premilking Sanatize	**Prewash Rinse**	**Detergent Wash**	**Acid Rinse**	**Other**
Start Temp					
Start Temp					
Cycle Time					
Product Used					
Label Concentration					
Label Temp					
Other Measurements (pH, alkalinity, etc.)					
Guidelines	Follow label instructions for time temp, and concentration	110 - 130 F (43-57C)	Follow label Instructions. (6-10 min, 120 F, typical	Follow label instructions. (2 min, 90-110 F typical)	

Part 2b CIP Sytem Design

Sketch the milking machine CIP on page 93

Measure length and diameter of all lines and indicate the location of air injectors.

Type of system: Parlor ☐ Round-the-barn ☐

Number of units: _____

Claw type: _____

Shell and liner type:_____

Milk meters or weigh jar type: _____

Other equipment: _____

Automatic washer type: _____

Washline diameter: _____

Air injector types: _____

Milk/wash valve type: _____paddle _____butterfly _____plug

Yes **No** Restrictors on jetters or jetter hoses? Hole sizes _____

Yes **No** Restrictors on wash lines? Hole sizes_____

Date of last liner change_____ How often are liners changed?_____

Date of last change of hoses and other rubber parts_____

Other CIP system notes or characteristics:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Part 3 — Water quantity and quality

Water hardness_____

Water iron content_____

Water softener? **Yes** **No**

Is water softener charged **Yes** **No**

Water Heater	Temp	Capacity
Tank 1		
Tank 2		
Tank 3		
	Wash sink	

Other water test results_____

Determine the minimum water volume required per wash cycle for proper flow dynamics in air-injected milking systems. Use this estimate to size wash sinks in new systems or to check if the actual water used per cycle is higher or lower than the minimum requirement. The requirement for milk meters, wash vat and precoolers are approximate and may vary with different component designs. If air injection is not used multiply the total gallons for the milkline by 3. If weigh jars are used, multiply the milk meter gallons by 4.

		(x) Multiplier		(=) Gallons
Feet of milkline				
	Line diameter 4 in.	x	0.12	=
	Line diameter 3 in.	x	0.07	=
	Line diameter 2.5 in.	x	0.05	=
	Line diameter 2 in.	x	0.03	=
	Line diameter 1.5 in.	x	0.02	=
Feet of wash draw and milk transfer line				
	Line diameter 3 in.	x	0.34	=
	Line diameter 2.5 in.	x	0.23	=
	Line diameter 2 in.	x	0.15	=
	Line diameter 1.5 in.	x	0.09	=
Receiver(s) Volume (gallons)				
		x	0.33	=
Number of milking units				
		x	0.25	=
Number of milk meters				
		x	0.25	=
Feet of milk hose				
	Hose diameter 9/16 in	x	0.012	=
	Hose diameter 5/8 in	x	0.012	=
Number of precoolers				
		x	2	=
Number of wash vats				
		x	8	=
		Total Gallons		=

Part 4 Unit Flow Measurement for Milking Parlors

Measure unit flow at first, middle and last unit on each side of the parlor. Also measure any units that appear dirty. Unit flow analysis; units should have no less than 3 L/min with no more than 50% variation between highest and lowest unit. Higher flowrate may be required to clean some components such as milk meters or weigh jars. Consult manufacturers recommendation.

Unit No. (Refer to sketch)	**Restrictor type and size**	**Water Volume (Liters or lb.)**	**Time of sample (min)**	**Average flow rate** (L/min or lb./min)
As Found				
After Change				

Part 5 Milkline Slug Flow Analysis

Estimate Air injector open time	Injector 1	Injector 2
Slug travel distance from air injector through air injector line and milkline to receiver (feet or meters)		
Expected air injector open time: divide slug travel distance by 28 ft/sec (8.5 m/s) or other slug speed (seconds)		
Estimate expected time between vacuum drop at test points	**Injector 1**	**Injector 2**
Distance between test points (points at which vacuum recorder attached to milk line) (feet or meters)		
Time between vacuum drops: divide distance between test points by 28 ft/sec (8.5 m/s) or other slug speed (seconds)		

Vacuum Drop and Slug Speed Measurements: Attach vacuum recordings to form

			If Sequenced		Time between vacuum drop at test points		Slug Speed		Vacuum Drop At Test Points			
	Injector Closed	Milkline injector open	Washline injector open	Injector airflow rate setting	Loop 1	Loop 2	Loop 1	Loop 2	Loop 1 Point 1	Loop 1 Point 2	Loop 2 Point 1	Loop 2 Point 2
As Found												
1st Adjustment												
2nd Adjustment												
3rd Adjustment												
Final Setting												
Guideline	Long enough to form a slug	Just long enough to move slug to receiver	Just long enough to clear wash line	Adjust air flowrate to change slug speed			23 - 33 ft/sec 7 - 10 m/s		4 - 9 in. (12-30) Hg for 3" line 5-7 in Hg. (18-25kPa for 2 in. line			

Vacuum Drop at other locations

Location (refer to sketch)											
Vacuum Drop											

RESOURCES MILK MONEY

Farm Visitor Biosafety

Keeping Animals and Visitors Healthy

Pamela Ruegg, DVM, MPVM, Extension Milk Quality Specialist
University of Wisconsin - Madison

Farm visits are an exciting way to demonstrate the care that goes into raising healthy animals. Allowing visitors access to animals is often the most popular part of farm visits but does pose some risks to both the visitors and the farm animals. Some simple precautions taken before and during the farm visit can help to ensure that the visit is safe for both the visitors and the animals.

- **Potential Risks to Farm Visitors**.

Contact with farm animals has been demonstrated to be risk factor for the transmission of several organisms that can cause disease in humans. Human pathogens such as *E. coli* O157:H7, *Salmonella, Listeria, cryptosporidia* and *Campylobacter* can be shed in manure or raw milk (even in some healthy animals!) and can be transmitted to humans.

- **Understanding Risks**

Certain farm animals have a greater risk for transmitting infections to humans as compared to others. In general, calves, recently fresh cows and sick animals are more likely to shed human pathogens as compared to other farm animals. They are also the most susceptible animals to acquire contagious animal diseases.

- **Keep Food and Animals Separate**

Don't mix food and animals – one of the greatest risks to visitors is contact with manure. Many calves shed *Campylobacter* (the #1 cause of diarrhea in humans), *cryptosporidia* and *Salmonella* in their manure. If children contact calves and then put their hands in their mouths or handle food - they are at risk. If you have treats for the kids or if they bring lunches - feed them well away from the animals and make sure that they clean their hands before eating. Better yet - feed them first before they contact animals (they should still wash their hands).

- **Consider the Age Group**

Little children probably can't keep their hands out of their mouths and probably shouldn't touch the calves. Big kids should have proper hygiene explained to them and if you let them feed or pet the calves, have them immediately clean and dry their hands with soap and running water. If running water is not available a waterless hand cleaner or antibacterial hand wipes can be substituted but the ability of these substances to successfully inactivate pathogens has not been documented under farm conditions.

- **Keep Visitors Away From Sick Animals**

Keep visitors out of fresh pens and sick cow areas. This commonsense precaution will also help keep visitors away from needles and syringes.

- **Serve ONLY dairy products made from pasteurized milk**.

Every year people get sick from the consumption of raw milk and raw milk products. Young children (<5 years of age), elderly, pregnant women and immunocompromised persons (those with HIV/AIDS or undergoing chemotherapy) are especially at risk from these products.