UDDER PREPARATION FOR QUALITY MILK PRODUCTION

Jeffrey K. Reneau, DVM, MS
Milker Training Workshops

Introduction

Key to the consistent success of the modern dairy is the profitable production of high quality milk. Every dairy knows this is a constant challenge. Expanding global dairy markets and world wide consumer pre-occupation with food quality and safety will continue to place more pressure on dairies to provide wholesome, high quality and safe dairy products. This comes at a time when there is considerable economic pressure on dairies. Therefore, modern dairies are searching for management strategies to make more efficient use of materials and labor to stay both competitive and profitable. Over 50% of the labor and an equally high share of the fixed cost of a dairy is expended for milking the cows. It is easy to understand why cost conscious dairy managers are striving to make more cost−effective use of milking labor, equipment and materials while still meeting the consumer's relentless demand for quality. The "good news" is that those management practices that result in high quality milk will also result in good herd health and efficient milk production.

Recently there have been many advances in herd management technology. Advances in genetics and nutrition as well as bST use and/or 3X milking have all resulted in increased milk production. Simultaneously there have been improvements in milking equipment capacity, performance, and automation. All are examples of technological advancement that have had an impact on how cows should be milked. Modern dairies have become more dependent on high tech skill and products. However, it is good to keep in mind that new management approaches must respect the basic biological requirements of the cow (6). Milking procedure should be designed in synergy with cow physiology so as to optimize cow health, milk quality, human health, and practical and efficient use of labor and materials. The purpose of this paper is to focus attention on what is known today about cow prep procedure and how it can best be accomplished with the idea of optimizing cow health, milk quality, milker health and farm profitability. While there are basic scientific principles that govern what is acceptable cow prep procedure, every farm is different. Therefore, there is no single cow prep procedure that fits all dairy farms. It is hoped that review of these principles will be helpful in determining what is best for your dairy.

Cow Physiology

Milk letdown is necessary. Lactation in the dairy cow is dependent on the process of milk ejection (milk letdown). While this not true in the goat, it is true for the dairy cow. The requirement of milk letdown is dependent on the ratio of alveolar (milk secreting) tissue to cisternal (mammary gland ducts and cistern) capacity. The cisternal capacity of the goat mammary gland is 80% compared to 30% in the cow. In general, the higher the proportion of alveoli to cisternal capacity, the more important milk ejection will be (15). First lactation cows have lower cisternal capacity than do older cows. This explains their greater need for a good milk letdown response to achieve efficient milkout as well as their proportionately greater milk production response to more frequent milking.

Role of oxytocin. The role of oxytocin in achieving milk letdown is well known. However, milk letdown is more complex than a simple oxytocin response. Studies have shown that milk ejection from the alveolar tissue is not entirely dependent on the action of oxytocin and that there are many other factors that control the effectiveness of the oxytocin response (6, 8, 9, 19, 22).

Local nervous system reflex. The effect of teat stimulation on sympathetic nervous system tone in the mammary gland is a second milk letdown mechanism. Teat stimulation initiates a local autonomic reflex resulting in a decrease in smooth muscle tone around mammary ducts and teat sphincters. There is also an increase in blood flow to the mammary gland as well as a decrease in the response threshold of the myoepithelial cell to oxytocin (8). Although the local autonomic reflex letdown mechanism is independent of oxytocin for its effect, this mechanism potentiates oxytocin response. Together these two mechanism work to accomplish efficient milk removal.

Other factors. The effects of oxytocin on the mammary myoepithelial cell and the uterine smooth muscle cells are similar and are mediated by oxytocin receptors. Progesterone and estrogen levels regulate the availability of oxytocin receptors on uterine smooth muscle cells and are thought to have a similar effect on the mammary myoepithelial cell. Adequate levels of calcium in the diet are needed to ensure normal contraction of any smooth muscle cell including the mammary myoepithelial cell. Magnesium plays a role in oxytocin receptor availability and smooth muscle contractility. It is by this direct means that dietary magnesium effects milk butterfat percent. Cobalt and manganese also have been found to have roles in the effectiveness of the oxytocin response (8, 9, 19, 22). Clearly milk letdown is a complex mechanism.

Possible effect of reproductive cycle. It has been generally observed that milk letdown response varies with stage of lactation and level of production. Late lactation cows typically require more stimuli to achieve good milk letdown than early lactation cows. It can be reasoned that during early lactation, especially in high producing cows, milk letdown is more intense because: a) a more distended myoepithelial cell will contract with a greater force; and b) the cyclic exposure to estrogen in early lactation maintains the sensitivity of oxytocin receptor sites to oxytocin; thus, achieving a more powerful oxytocin response (22).

After the cow is pregnant and under the hormonal influence of progesterone, the affinity of oxytocin receptor sites for oxytocin declines and smooth muscle cells become less responsive (19). It can be theorized that the hormonal changes accompanying pregnancy shift milk letdown dependence more from the oxytocin mechanism to the local autonomic reflex controlled mechanism. It is thought, but not yet proven, that teat stimulation is more critical in eliciting the local autonomic reflex milk letdown mechanism than the oxytocin milk letdown mechanism.

Pre-milking stimulation. Prep time is defined as the time taken to manually clean and dry the teat surface. The object is to be sure that the teat surfaces are consistently clean and dry before the milking machine is attached and that adequate teat massage has occurred to stimulate milk letdown. With regard to pre-milking cow prep, Mein (11) states, "Today's high producing Holstein cows require very little stimulation for normal milk letdown. Therefore, the basis of a good pre-milking cow prep should be to ensure that teat cups are applied:

1) to visibly clean and dry teats with meticulous attention to detail, to reduce the risk of mastitis and to maintain top quality milk.
2) at or soon after milk ejection when teats are plump with milk.
3) with minimal time and effort for stimulation."

Some have interpreted "minimal time and effort" to mean no prep at all. Careful study of Mein's statement (above) and of the available data on this subject does not support that conclusion whatsoever. Recent studies demonstrate that less than 10 seconds is inadequate stimulus for consistent milk letdown response in all cows. While manual stimulation for 10 seconds will provide adequate milk letdown stimulus for American Holsteins in early lactation, it is not adequate for late lactation American Holsteins or European Fresians and Jersey cattle (15). Manual stimulation (washing, drying, forestripping) of 10 to 20 seconds does appear to be consistently adequate for most cows regardless of stage of lactation or milk production. It is often difficult to convince some milkers that taking sufficient pre-milking udder prep time to be assured of achieving adequate teat sanitation and milk letdown stimulus does not significantly lengthen total milking time. Some research data demonstrate that optimizing udder prep reduces milking time and improves cow throughput (18) while other data indicate that no prep will improve parlor throughput in a double 8 parlor from 75 cows per hour to 90 cows per hour (17). The differential labor cost for milking 300 cows 3 times each day using an optimal prep procedure (75 cows/person/hour) versus no prep (90 cows /person/hour) equates to 200 lbs of milk / cow/ year. Therefore, if the extra time spent properly preparing cows will yield more than 200 lbs of milk or result in higher quality milk then it is economically wise to prepare cows for milking properly.

Forestripping. Forestripping to check for clinical mastitis is a recommended premilking cow prep procedure. Today, many milkers resist forestripping because it is physically tiring and labor intensive. Forestripping, however, is a very powerful milk letdown stimulus and, therefore, is best used early during the cow prep procedure. However, if the premilking cow prep procedure is greater than 20 seconds, the addition of forestripping will add little advantage to milking efficiency (15). Therefore, in those circumstances where minimal cow prep (10 seconds) is being used the addition of forestripping to the cow prep procedure will ensure consistent milk letdown response.

Effect of more frequent milking. More frequent milking sets a higher standard on pre-milking udder prep (16). Cows milked more than 2X per day do not eject their milk as efficiently. It is thought that udder pressure may be a motivating factor for oxytocin release or, as mentioned previously, udder pressure effects the myoepithelial sensitivity to oxytocin. Therefore, a high quality cow prep is relatively more important in those herds using 3X milking than in 2X herds.

Timing of machine attachment. Prep lag time is the time between the beginning of teat preparation to the application of the milking machine. Rasmussen (16) defines optimal milking efficiency as the highest possible milk yield obtained without milking on empty teats. Recent U.S. and Denmark studies have determined that prep lag timing is the most important factor in optimizing milking efficiency. These studies report the ideal prep lag time to be 1.3 minutes (1 minute and 18 seconds) (15). The range of 1 to 1.5 minutes is accepted as the optimal prep lag for all stages of lactation. Prep lag times of greater than 3 minutes were found to result in more residual milk and lower milk yields regardless of stage of lactation (15). Excessively long prep lag times are more common in stall barn milking and likely limit herd performance. It seems clear that more effort needs to be made in using routines that optimize prep lag times.

Teat condition. In spite of the fact that the milking machine is capable of creating consistent milk letdown stimulation, it is undesirable to attach milking units before milk letdown has occurred. Attachment of the milking machine prior to milk letdown results in milking on empty teats, longer machine-on times and a greater risk of air slip-induced reverse flow impacts. It also causes unnecessary wear and tear on the teat. The milking machine is the main source of teat canal erosion, hemorrhagic blisters near the teat end, and much teat chapping (11). Therefore, it is wise to minimize the time the machine is on the cow whenever possible. When we consider that it will take longer to milk today's high producing cows because of higher production (1 minute/10 lb) and that many are being milked 3X each day, it makes good sense to time machine attachment to maximize milk flow rate and minimize the time the machine is on the cow. This will reduce the risk of new infections and/or unnecessary teat deterioration.

Rasmussen suggests when cows are being milked 3 times per day or more, that the automatic takeoffs be set to remove the units sooner (15, 16). When the threshold setting on the automatic takeoffs was raised from .44 to .9 lb/minute, the average time the machine was on the cow was reduced by 0.5 minutes and teat condition improved. There was no change in either milk yield or milk composition. Adjusting the delay time from 20-30 seconds to 10 seconds after the threshold is reached can also reduce total time the machine is attached and speed parlor throughput (11). Caution is advised since incomplete milking over several days will lower lactation yield. However, as long as a complete milk letdown has occurred, leaving only small amounts of milk (1 to 2 lb) in the gland and teat cistern will not lower lactation yield (15) nor increase the threat of mastitis except in quarters infected with major pathogens (3).

Standardization

Cows love routine. They perform best when all feeding, milking, or any other management routine is done the exact same way every day (6). Complete lactation studies demonstrate a 5.5% increase in lactational yield when a standardized milking routine was used compared to an impulsive and variable milking routine (14). This evidence supports the recommendation that the milking routine be designed so every cow is milked exactly the same at every milking regardless of stage of lactation or who is milker.

Teat Cleanliness, Milk Quality, and Udder Health

Studies show that good cleaning and drying with separate towels will reduce bacterial populations on teat surfaces 75% (4). Predip data demonstrate that improved teat sanitation reduces intramammary infection rate (2, 5, 13).

Cow cleanliness has a great effect on cow prep efficiency. It is estimated that dirty cows will easily double cow prep time and, thus, unnecessarily slow down parlor throughput. Management practices such as clipping or "flaming" udders, docking tails, and providing freshly bedded, clean, dry and comfortable stalls will help to facilitate efficient pre-milking cow prep while improving milk quality and reducing mastitis risk.

Whatever bacteria is not removed from the teat surface before machine attachment will end up in the milk. In the past, we have worried more about mastitis pathogens and the risk of mastitis; however, there is building concern about those bacteria affecting milk quality and food safety. There has been concern about Psychrophilic bacteria and milk quality for some time. Psychrophilic bacteria are normal inhabitants of the cows' environment. Teat surfaces are usually contaminated with these bacteria. These bacteria are undesirable contaminants of milk because they thrive well at refrigeration temperatures and can survive pasteurization. Recent Wisconsin studies have found that these bacteria are the source of proteolytic enzymes or plasminogen activators that reduce dairy product shelf life and yield (1). Plasminogen is a normal component of milk. In the presence of plasminogen activators, it is transformed into the active enzyme for Plasmin. Plasmin degrades milk casein. Plasmin activity continues during cold storage and survives high temperature treatment of dairy processing. This is of great concern among dairy processors. Salmonella and Listeria are bacteria of human health concern. These are also found in the cows' environment and could easily contaminate teat surfaces. In light of these emerging concerns, it is doubtful that there will be any lessening of current PMO (Pasteurized Milk Ordinance) requirements to clean teat surfaces prior to milking. Dairy managers need to find practical ways to include pre-milking teat sanitation into every milking routine in order to ensure milk quality and safety.

Ergonomics and Milking Routine

What about milker health? Little effort has been spent determining which milking procedures work best from the standpoint of human health and safety. It seems clear that stall barn milking predisposes milkers to chronic knee and back injury. However, very little is known about the ergonomics of working long shifts in milking parlors. In other industry studies, workers that were exposed to high-force, highly repetitive manual movements (e.g., forestripping) for long periods of time had a higher prevalence of carpal tunnel syndrome. However, there are many factors that must be considered before any conclusion can be made regarding chronic musculoskeletal disorders related to milking routine. Certainly, as the average herd size increases and milking shifts lengthen, there is need for study in this area (12).

Conclusions

In light of what is known about milk quality, udder health and cow physiology, it seems clear that a minimal pre-milking udder preparation should be a part of every milking routine. This pre-milking udder prep procedure should be effective in removing teat surface bacterial contamination as well as providing an effective milk letdown stimulus in 20 seconds or less. The timing of machine attachment is the most crucial factor for efficient milking. Milking machines should be applied 1 to 1.5 minutes after the beginning of udder prep. The milking routine should be standardized so that every cow is milked the same at every milking throughout her lactation regardless of stage of lactation or who is doing the milking.

What Should be Done on Your Farm?

1. Do a complete analysis of your present milking routine in light of the above principles.
2. Design a practical milking routine with due consideration of your facility, milking equipment and milking personnel. Develop a written milking routine protocol for use as a job description and for training new employees.
3. Have routine milker meetings to train milkers, boost morale and to problem solve. Use available milking routine training videos (e.g., One-Step Cow Prep - 3M, or Milk Them for All Their Worth - ABS) as training aids.
4. Establish specific standards of performance (e.g., 100,000 SCC, or less than 5,000 Standard Plate Count) and keep milkers informed of how they are doing by charting performance measures of milk quality and mastitis. Praise milkers when they are doing a good job and challenge them to be continuously looking for ways for improvement.

References

1. Ballou, L.U., M.P. Pasquini, B.D. Bremell, T. Everson, and D. Sommer. 1995. Factors affecting herd milk composition and milk plasmin at four somatic cell counts. J. Dairy Sci. 78:2185-2195
2. Drendle, T.R., P.C. Hoffman, A.N. Bringe, and T.Y. Syverud. 1993. The effect of premilking teat disinfection on SCC and clinical mastitis. R359A. University of Wisconsin, Madison, College of Agriculture and Life Sciences.
3. Fox, L.K. and L.H. Schultz. 1985. Effect of infection status on quarter milk production and composition following omitted milking. J. Dairy Sci. 68:418-423.
4. Galton, D.M., L.G. Peterson and W.G. Merrill. 1986. The effects of premilking udder preparation practices on bacterial counts in milk and on teats. J. Dairy Sci. 69:260-266.

5. Galton, D.M., L.G. Peterson and W.G. Merrill. 1988. Evaluation of udder prep on intramammary infections. J. Dairy Sci. 71:1417-1421.

6. Hurnik, J.F. 1994. An ethological approach to the management of dairy parlors. Proc. Natl. Mastitis Council Annual Meeting. Feb. 1994. Kansas City, MO.

7. Gorewit, R.C. and K.B. Gassman. 1985. Effects of duration of udder stimulation and milking dynamics and oxytocin release. J. Dairy Sci. 68:1813-1818.

8. Lefcourt, A. 1982. Effect of teat stimulation on sympathetic tone in bovine mammary gland. J. Dairy Sci. 65:2317-2322.

9. Lefcourt, A. and R.M. Akers. 1983. Is oxytocin really necessary for efficient milk removal in dairy cows? J. Dairy Sci. 66:2251-2259.

10. Mayer, H., D. Schams, H. Worstorff and A. Prokopp. 1984. Secretion of oxytocin and milk removal as affected by milking cows with and without stimulation. J. Endo. 103:355-361.

11. Mein, G. 1995. Design and performance of milking systems. Proc. 2nd Western Large Herd Dairy Conference, Las Vegas, NV. April 6-8, 1995.

12. Nordstrom, D. 1996. A population based, case control study of Carpal Tunnel Syndrome. Thesis, UW Madison.

13. Pankey, J.W., E.E. Wildman, P.A. Drechsler and J.S. Hogan. 1987. Field trial evaluation of premilking teat disinfection. J. Dairy Sci. 70:867-872.

14. Rasmussen, M.D. and E.S. Frimer. 1990. The Advantage in milking cows with a standard milking routine. J. Dairy Sci. 73:3472-3480.

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

16. Rasmussen, M.D. 1994. Possibilities for optimal milking efficiency. Proc. Internatl. Symposium: Prospects for Future Dairying: A Challenge for Science and Industry. Uppsala, Sweden, June 13-16.

17. Reinemann, Douglas J. 1996. Milking Center Options. Proc 4-State Dairy Expansion Conference. St. Paul, MN, November 13-14, 1996; Dubuque, IA. November 14-15, 1996

18. Reneau, J.K. and J.P. Chastain. 1995. Effect of Cow Prep On Milk Flow, Quality and Parlor throughput. Dairy Update Issue 119. Animal Science Extension, University of Minnesota.

19. Roberts, J.S., J.A. McCraken, J.E. Gavagan and M.S. Soloff. 1976. Oxytocin-stimulated release of prostaglandin F2 alpha from ovine endometrium in vitro: correlation with estrus cycle and oxytocin-receptor binding. Endocrinology 99:1107-1114.

20. Sagi, R., R.C. Gorewit and S.A. Zinn. 1980. Milk ejection in cows mechanically stimulated during late lactation. J. Dairy Sci. 63:1957-1960.

21. Sagi, R., R.C. Gorewit, W.G. Merrill and D.B. Wilson. 1980. Premilking stimulation effects on performance and oxytocin release in cows. J. Dairy Sci. 63:800-806.

22. Soloff, M. 1982. Oxytocin receptors and mammary gland myoepithelial cells. J. Dairy Sci. 65:326-337.