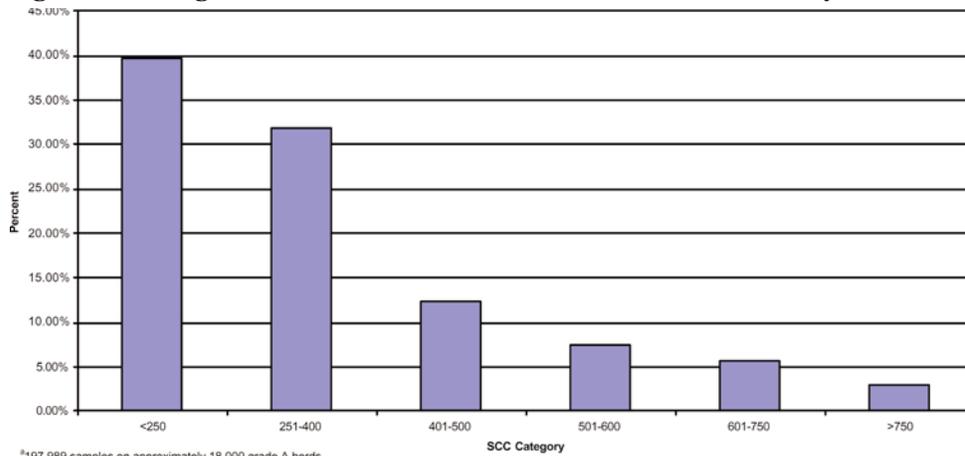


The Seven Habits of Highly Successful Milking Routines

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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*



Producers of high quality milk know that a consistent method of pre-milking 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 (≤ 60 lbs/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.

Grouping	Double 8		Double 16	
	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%).

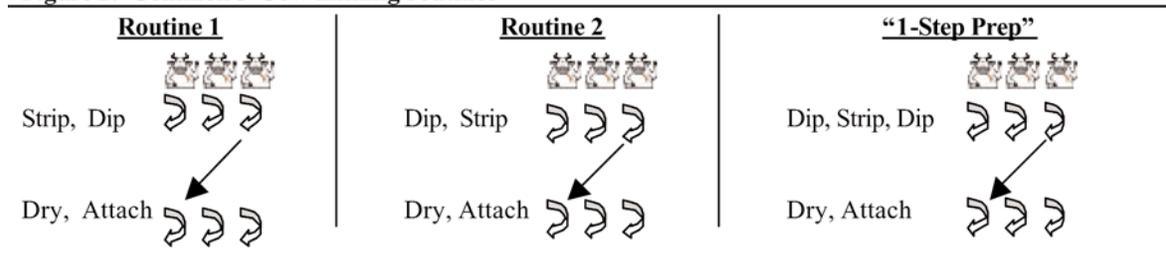
To check the effectiveness of teat disinfection and drying, a clean swab can be rubbed across the end of the teat prior to unit attachment. A swab from a properly prepared teat will remain clean. A dirty swab indicates that teat preparation methods should be improved.

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

^acows 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.



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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

