

Controlling Contamination of Milk and Reducing Udder Infection Using Practical Steps in Dairy Hygiene

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Hygienic procedures as practiced on the modern dairy play a primary role in maintaining high standards for quality in milk production and in reducing the incidence of mastitic infections which have become the major economic disease influencing dairy production profits.

The microorganisms present in milk are from two sources: (1) the *contagious mastitis pathogens* commonly found in the internal tissues of the mammary gland; and (2) the *ubiquitous environmental organisms* contaminating the external teat and udder surfaces. Both groups of organisms contribute to the total population present in the bulk milk received at the creamery. Increased somatic cells and high bacterial numbers contribute to low milk solids and cheese yields. In addition, shelf life and flavor are directly affected by the environmental thermophilic and psychrophilic bacteria. As larger numbers of cows are congregated, there is a tendency toward neglect of good milking procedures, and the opportunity increases for contagious mastitis infections to pass from cow to cow, and for environmental infections to occur. Milking machine function, milking techniques, and the level of sanitation in the milking barn, all directly influence the incidence of mastitis in a herd.

The value of good sanitation at milking time is well-documented. Very simple sanitation measures often have proved effective in controlling mastitis. Many dairymen find that post-milking teat-dipping alone successfully reduces the number of mastitis cases in a herd. But on larger dairies with extensively mechanized systems, maintaining a high level of sanitation in the milking parlor is more complicated and burdensome.

For practical purposes, milking-parlor sanitation must be separated into three phases:

1. Premilking sanitation.
2. Cleansing of the milking unit after each cow is milked and reducing organisms on the milker's hands.
3. Dipping teats in an effective germicide post milking.

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Premilking Sanitation

Sanitizing the udders of cows before milking is doubly beneficial: It reduces the opportunity for environmental organisms to gain entrance into the final milk product; and it minimizes exposure to the udder to environmental mastitis pathogens.

All of the environmentally caused infections can be reduced effectively by premilking sanitation. Therefore, when encountering environmentally induced clinical mastitis or increased somatic cell counts, the dairy practitioner should emphasize the basic principles of premilking hygiene.

The many types of microorganisms present on the external surface of the udder include the fecal, soil and water coliforms, streptococci, and bacilli, yeasts and fungi, and major populations of environmental staphylococci, such as *Staphylococcus epidermidis*, from the mammary skin.

The species in this abundant microflora differ in several respects: ability to survive pasteurization, pathogenic potential as agents of mastitis, and susceptibility to various sanitizers.

Constantly changing environmental factors—such as rain, sunshine, mud, manure, and bedding materials— influence the relative populations of these organisms, causing seasonal, daily and individual fluctuations. Excessive udder hair and cracked, dry skin invite soil and bacterial accumulation, making sanitation more difficult.

Water is the most effective and efficient remover of excessive soil from cows' udders, but improperly used, water transports bacteria down the teat and into the milk during milking. It is therefore imperative that cows be dry when milked.

The bacterial content of water may add to environmental organism infections when wells, holding cisterns, old water lines, and cracked rubber hoses are contaminated. *Pseudomonas*, yeasts, coliforms, and non-*agalactiae* *Streptococcus* are frequently encountered in water supplies at potentially hazardous levels. Periodic examination of water at various locations in the water system is recommended.

On large dairies, proper cow washing begins with the correct design, maintenance, and use of group sprinkler pens. An adequate drip-dry time of 10-15 minutes after

washing is of major importance. Three-times-a-day milking and other trends to maximize milking facilities affect the overall ability of the dairy to apply proper group washing techniques, including adequate drip-dry time.

Slipping liners, improper vacuum, and faulty pulsation in the presence of excessive teat surface moisture aid the intrusion of contaminating bacteria into the claw during the milking process.

Washing procedures that include washer primers or excessive use of barn hoses just prior to attachment of milking units often prove detrimental. Low-level sanitizers (such as 25 ppm iodophor solutions or 100 ppm chlorinating mixtures) in barn hoses and cow washers offer little benefit in reducing bacteria on cows' udders and teats. Even with the higher concentration of sanitizers, sufficient germicidal action is difficult to achieve in the presence of organic material during the usually short preparation period.

The presence of environmental bacteria in the bulk-tank milk is a good indicator of poor milking parlor sanitation which is useful to sanitarians in their evaluation of a dairy.

For effective removal of undesirable soil and bacterial contamination from udders of cows maintained under different husbandry systems, some fundamentals must be observed.

1. Cow should enter the milking parlor as clean and dry as possible, with 10-15 minutes of drip-dry time allowed after group washing.
2. Each cow with a dirty udder should be washed with a barn hose and dried with a paper towel. Even when the barn hose water contains a low-level sanitizer, the *physical washing and subsequent drying are the important steps*. Most cows, if clean, should be left unwashed.
3. The use of low-level sanitizers in milking parlor hoses should be encouraged for cleaning milkers' hands and hard surfaces such as milking equipment.
4. The length of time available to sanitize the teats after the cow enters the milking barn is very limited, usually from as little as 5 seconds in a side-opening parlor to as long as 2 minutes in a herringbone parlor. Improper washing causes more harm than good. Changing the milker's routine can enhance cow preparation and improve the entire milking procedure.
5. *The final sanitizing steps before the milking unit is attached* should be concentrated on the teats and should not include wetting the udder.
6. *Workers should not be permitted to wet the cow or the milking unit* while milking is in progress.
7. Several physical and chemical factors influence the acceptable removal of soil and bacteria from udder surfaces:
 - a. the total organic material and bacteria present on the udder.
 - b. the amount of hair present on the udder.
 - c. the degree of flushing action of the washing procedure.

- d. the detergent action during washing.
 - e. concentration of the sanitizer.
 - f. length of time the sanitizer is in contact with the bacteria.
 - g. concentration and types of any chemicals used that may irritate the skin.
 - h. preventing chemical residues from reaching the milk.
8. Mechanical devices currently available allow sanitizing of the teat with minimal wetting of the udder. The higher concentrations of sanitizers are effective against coliform and other bacteria (table 1), but continued use of these high concentrations can irritate the milker's hands. Chemicals used at levels higher than recommended cause teat irritation.
 9. Immersing teats in commercially available teat dips just prior to milking, if properly done, can lower the incidence of coliform and environmental *Streptococcus* mastitis as well as reduce milk contamination.

Teat dips tend to be more germicidal in shorter periods of time and have proved to be efficacious in well-managed herds. They are much less effective when cows are wet or dirty or when insufficient time is allowed for their contact with the teat.

The high-concentration teat dips (1% iodines) are more bactericidal, but they tend to adhere strongly to the skin, *have a higher potential for skin irritation, and offer a greater risk for milk contamination*. Although the low-concentration germicidal dips are less effective against organisms, they have the advantage of *causing less skin irritation and producing less detectable residues in milk*. The high detergent dips are more effective as physical removers of soil and bacteria when only short periods of time (less than 1 minute) are available for cow preparation.

Before attaching the milking unit, *it is imperative to remove the dip by wiping the teats with a paper towel; this lowers the risk of milk contamination and further helps remove bacteria*.

In a trial measuring the efficacy and safety of pre-milking dipping with a low-iodine dip, new cases of clinical coliform mastitis were reduced by 80% or more. Removing the dip with paper towels prevented any measurable increase in the milk iodides. Failure to wipe the dip from cows before milking caused an increase of measurable iodides in the milk (350 µg/liter).

Sanitizing the Milking Unit and Milkers' Hands Between Cows

In larger dairies, a persistently high prevalence of subclinical mammary infection together with an undesirable rate of clinical disease can exist in the presence of standard routines for teat dipping and dry cow therapy. Epizootics of highly contagious infections such as *Mycoplasma bovis* can also occur.

With automated take-offs, the milker no longer must return to the cow to remove the machine, so teat-dipping

TABLE 1. Premilking Teat Sanitation with Hand-Held Teat Washer with Excellent Flushing Action.

Product	% Reduction Bacteria		
	Staph.	Coli.	Total
Water 20°C	0	72	54
Iodine 25 ppm	0	76	71
Iodine 80 ppm	0	84	84
Iodine 100 ppm	50	95	87
Iodine 200 ppm	90	100	98

30 seconds contact time and udders dried with paper towels.

TABLE 2. Effectiveness of Backflush Systems in Removing Organisms from Liners.

Iodine ppm	pH of Solution	Flushing Action	Percent of Liners Still Contaminated after Flushing	
			Staph	Mycoplasma
23*	3.9	Poor*	100	
12*	5.0*	Good	100	22
23*	3.5	Poor*	72	
50	2.9	Poor*	63	
23*	5.6*	Excellent	43	
27	2.4	Good	23	
53	2.6	Excellent	17	
40	3.0	Excellent	8	
40	2.9	Good	0	0
30	3.1	Very good	0	0

*Indicates area of deficiency in the system, giving poor bacterial removal.

after milking is frequently inadequate or abandoned altogether. Workers may resist performing even simple sanitizing measures that require added movements or time in the milking barn. Under these conditions backflushing becomes an asset.

Sanitizing the internal and external milking unit as well as the milker's hands reduces the contamination by contagious pathogens shed in the milk of infected cows in sufficient numbers to infect cows milked subsequently with the same cluster. These contagious pathogens include *Streptococcus agalactiae*, *Staphylococcus aureus* and the *Mycoplasma* species. A minor benefit is the reduction of environmental organisms such as the coliforms and streptococci, but unit backflush systems should never be installed for the sole purpose of controlling environmental pathogens.

Several factors determine the design of a procedure for cleansing the milking unit.

1. the types of organisms to be eliminated and the differences in their susceptibility to germicides.
2. the type and concentration of the sanitizing compounds to be used.
3. the inherent irritating and corrosive nature of some sanitizers.
4. the effects of water quality, pH and hardness on the sanitizer.

5. potential contamination of the milk with harmful levels of chemicals.
6. a practical mechanical method of application.
7. adequate flushing action of the equipment, which is dependent upon line size, pressure and volume of water, and mechanical design.
8. the economic justification of both the equipment and sanitizers through improved milk quality and mastitis control.

On most large dairies, mastitis is reduced when backflushing is added to the standard sanitizing routine, including teat-dipping.

TABLE 3. Sanitizing Teats Before Milking Using a Mechanical Unit to Flush Teats.

Product	PH	Coliform		Total Bacteria	
		Population	% Removal	Population	% Removal
Water	8	70,000	51	200,000	37
Acid Detergent					
50 ppm	7	22,000	57	155,000	53
100 ppm	4	16,000	58	135,000	51
Iodine					
250 ppm	7	18,000	53	145,000	52
500 ppm	6	37,000	65	135,000	68
1000 ppm	4	23,000	75	180,000	75

25 Paired Swabs in each product on 2 Dairies with 2-Minute Contact Time.

TABLE 4. Sanitizing Teats With Teat Dips Before Milking.

Product	Coliform		Total Bacteria	
	Population	% Removal	Population	% Removal
1% Iodine	89,000	98	310,000	88
1% Iodine	68,000	91	190,000	88
.5% Iodine	41,000	88	500,000	89
.25% Iodine	59,000	68	240,000	64
.1% Iodine	30,000	72	167,000	37
1% Chlorine	59,000	58	270,000	45
LDBSA*	57,000	81	145,000	82
Alcohol Complex	38,000	77	180,000	73

25 Paired Swabs in each product on 2 Dairies with 2-Minute Contact Time.

*Linear-dodecyl-benzene-sulfonic acid

TABLE 5. Pre-Milking Teat Sanitation With Hand-Held Teat Washer.

Product	% Reduction Bacteria		
	Staph.	Coli.	Total
Water 20°C	0	72	54
Iodine 25 ppm	0	76	71
Iodine 80 ppm	0	84	84
Iodine 100 ppm	50	95	87
Iodine 200 ppm	90	100	98

Excellent flushing action. 30 seconds contact time and udders dried with paper towels.

External unit sanitation usually relies on drop hose sanitizers used by the milkers, occasional automatic unit washers, or immersing the cluster in a bucket sanitizer.

Milker hand hygiene comes via the drop hose or through hand contact with the teat dip in priming cows that have been predipped.

The major pathogens to be removed from the liner surface are all susceptible to the iodine and chlorine sanitizers. Observers concur that the acid-iodophor sanitizers prolong the useful life of both natural and synthetic rubber liners. The chlorinating compounds, on the other hand, tend to be detrimental to liner life.

Iodophor sanitizers, at concentrations ranging from 25 to 75 ppm iodine, and with different concentrations of phosphoric acid, have been used in backflushing. When concentrations of iodine approach 50 ppm, milkers in some milking facilities may complain of eye irritation.

The bactericidal action of the final sanitizing solution appears to be enhanced when the pH is below 4 and inadequate when the pH is above 6.

Dipping Teats Post Milking in an Effective Germicide

Many excellent summaries have been written about teat dips and their use after milking. Principally, the procedure aids in reducing contagious mastitis infections caused by *Staphylococcus aureus*, *Streptococcus agalactiae* and the *Mycoplasma* species. There is good evidence that teat dips used after milking reduce new infections from these organisms by 50% or more.

Teat dipping post-milking may also have benefit in combatting infections caused by some of the environmental streptococci (*S. uberis*, *agalactiae*, *fecalis*, etc.) but appear to offer very little, if any, protection against the other environmental pathogens (coliform). Teat dipping prior to milking appears far more effective in reducing the coliform bacteria on the teat surface.

Of the many formulations of teat dips being marketed, the iodine-based dips still appear superior to others for controlling the spread of the major contagious pathogens.

The more highly concentrated products provide germicidal action that is superior to the more dilute products of similar formulations. In general, the dips with lower germicidal action properties may produce less skin irritation.

Herds nominally "free" of contagious mastitis infections may do well on the lower concentration dips, but for herds with a high incidence of infection and in epidemics of *Staphylococcus*, *Streptococcus agalactiae* and *Mycoplasma* species, the 1% iodine-based dips prove to be superior to most other formulations in stopping the spread of infection.

In a milking parlor where teat sanitation techniques are sound,

1. Teat-dip containers are maintained in a hygienic manner and are kept full.
2. All teats of all cows are dipped within 1-2 minutes after

the milking unit is removed.

3. Both the end and lateral surfaces of the teat are covered with dip.
4. The cows do not contact sprinkler water while exiting the parlor, which dilutes the effectiveness of the dip.
5. Because many organisms can survive in germicidal products, teat dips must be guarded against gross contamination through negligent handling.

Hygienic Procedures during Intramammary Infusion

Intramammary infusion is potentially a dangerous procedure. Many dairies have experienced contaminations from poor udder infusion practices. The mammary gland, even in the early stages of inflammation, is susceptible to infection from environmental organisms, including some species of nocardia, yeasts, mycobacteria, pseudomonas, and *Bacillus cereus*, as well as the mycoplasmas. Most of these organisms are capable of multiplying in the alveolar spaces in the presence of antibiotics and during the process of inflammation.

Steps recommended to guard against contamination during infusion in dry-cow therapy and in the treatment of clinical disease include:

1. dipping all teats in a 1% iodine dip both before and after mammary infusion.
2. cleaning the teat ends with cotton swabs dipped in alcohol.
3. using separate syringes for each teat infusion.
4. rinsing hands after each treatment with a 25-50 ppm iodine sanitizer.

Sanitary Handling of Fresh Cows, Fresh Heifers and Sick Animals

Fresh cows and sick cows are at high risk for mammary gland infection. Not only does the udder appear to be more susceptible during these periods, but because this milk is not sold for human consumption, the milking process is often done under inferior hygiene conditions. Less care is taken in cleaning the udder before milking, in sanitizing the milking machine between cows, and in teat-dipping most milking.

Uterine discharges present post calving deposit many bacteria, mycoplasma and other pathogens on the teats and udders. The fresh animal is seldom milked out completely, and her alveolar secretions undergo rapid changes from colostrum to normal milk. This combination of factors enhances the risk of mastitis.

Because pathogens are often increased in the environment of the sick cow, where immunity may be reduced, extra attention should be given in sanitizing and milking sick animals.

Since milk from these animals does not reach the consuming public, sanitizer residues do not present a problem. Therefore, prior to milking, in addition to the cleaning and drying of udders, teats should be dipped in a 1%

iodine product. The dip should be left on the teats while the unit is attached to reduce the number of organisms on the teat surface during milking. Teat dips cannot be left on normal cows during milking when the milk is shipped for human use.

Teat-dipping post milking and sanitizing the milking machine between cows are both recommended. If unit sanitizing is not routinely practiced in the milking parlor, it should at least be instituted for milking the fresh and sick cow. A simple measure is to immerse the entire milking

cluster (with vacuum shut off), including the shells and claw, in a 5-gallon bucket containing 200 ppm iodine sanitizer. It is not necessary to rinse the unit prior to milking since the milk of these animals is not consumed.

The three principles of sanitation—pre-milking sanitation, cleansing the milking unit after each cow is milked, and post-milking dipping of teats in a germicide—along with culling, segregation and proper treatment methods, limit udder infections on large dairies to an acceptable economic level.