AS-1129

Mastitis Control Programs

Bovine Mastitis and Milking Management

J. W. Schroeder, Extension Dairy Specialist

Mastitis is complex; there is no simple solution to its control. Some aspects are well understood and documented in the scientific literature. Others are controversial, and opinions are often presented as facts. The information and interpretations presented here represent the best judgments currently accepted by the National Mastitis Council.

To simplify understanding of the mastitis complex, it is useful to consider that three major factors are involved in this disease: the *microorganisms* as the causative agent, the *cow* as host, and the *environment*, which can influence both the cow and the microorganisms. (Figure 1.)

Well over 100 different microorganisms can cause mastitis, and these vary greatly in the route by which they reach the cow and in the nature of the disease they cause.

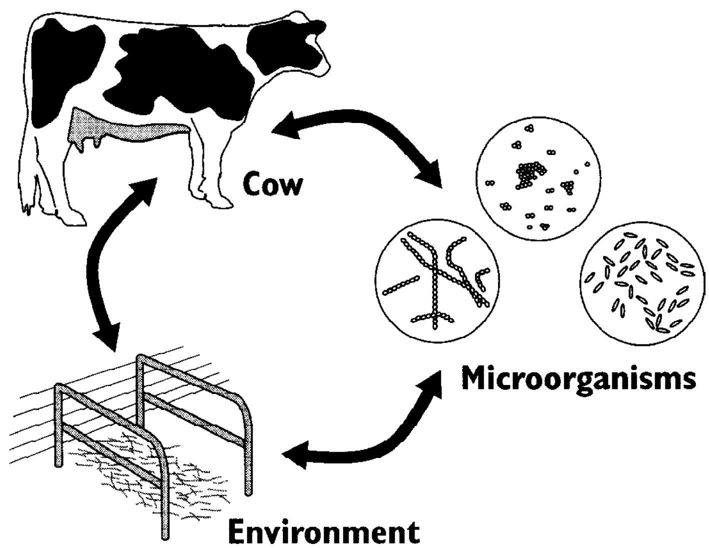

Figure 1.

Cows contract udder infection at different ages and at different stages of the lactation cycle. Cows also vary in their ability to overcome an infection once it has been established. Therefore, the cow plays an active role in the development of mastitis.

The cows' environment influences both the numbers and types of bacteria they are exposed to and their ability to resist these microorganisms. However, through appropriate management practices, the environment can be controlled to reduce this exposure and enhance resistance to udder disease.

Practical measures are now available to maintain common forms of mastitis at relatively low and acceptable levels in the majority of herds. While continued research is needed to control the less common forms of intramammary infection, herd problems are often the result of failure to apply the proven mastitis control practices consistently and to consider all aspects of the disease problem.

NDSU EXTENSION SERVICE
North Dakota State University, Fargo, ND 58105

APRIL 1997

Definitions

Mastitis — inflammation of the mammary gland caused by microorganisms, usually bacteria, that invade the udder, multiply, and produce toxins that are harmful to the mammary gland.

Clinical Mastitis — visible signs of mastitis which include:

Mild signs — flakes or clots in the milk, may have slight swelling of infected quarter.

Severe signs — secretion abnormal, hot, swollen quarter or udder; cow may have a fever, rapid pulse, loss of appetite, dehydration and depression; death may occur.

Subclinical Mastitis — no visible signs of the disease:

Somatic cell count (SCC) of the milk will be elevated.

Bacteriological culturing of milk will detect bacteria in the milk.

Causes the greatest financial loss to dairy farmers through lowered milk production.

For every clinical case of mastitis, there will be 15 to 40 sub-clinical cases.

Somatic Cell Count (SCC) — the number of leukocytes or white blood cells per milliliter of milk.

Normal milk will have less than 200,000 cells per milliliter.

An elevated SCC is an indication of inflammation in the udder.

Bulk tank SCC gives an indication of the level of sub-clinical mastitis and the loss of milk production in a herd due to mastitis.

Table 1. Estimated annual losses due to mastitis.[1]

Source of Loss	Loss per Cow ($)	Percent of Total (%)
Reduced Production	121.00	66.0
Discarded Milk	10.45	5.7
Replacement Cost	41.73	22.6
Extra Labor	1.14	.1
Treatment	7.36	4.1
Veterinary Services	2.72	1.5
TOTAL	**184.40**	**100.0**

[1]Assumptions: One-third of cows infected in an average of 1.5 quarters; milk loss 856 pounds per infected quarter; milk price $12.07 per hundred weight.

Source: Current Concepts in Bovine Mastitis, 1996. National Mastitis Council.

Economic Loss

Economic loss to mastitis in the United States is estimated to be approximately $185/cow annually. If we assume the same milk price and this value is multiplied by the total number of milking cows (9.5 million head), the total annual cost of mastitis is about $1.8 billion. This is approximately 10% of the total value of farm milk sales, and about two-thirds of this loss is due to reduced milk production in subclinically infected cows.

The average production loss per lactation for one infected quarter is about 1,600 pounds. Other losses are due to discarded abnormal milk and milk withheld from cows treated with antibiotic, costs of early replacement of affected cows, reduced sale value of culled cows, costs of drugs and veterinary services, and increased labor costs. The estimated costs of these factors are shown in Table 1.

These estimates do not include additional costs arising from mastitis-associated problems related to antibiotic residues in human foods, milk quality control, dairy manufacturing, nutritional quality of milk, degrading of milk supplies due to high bacteria or somatic cell counts, and interference with genetic improvement of dairy animals.

Economics of Mastitis Control

When analyzing the cost of mastitis control, consider first the cost in lost production. The bulk tank SCC is a good place to start. Table 2 estimates expected losses and prevalence of infection for elevated bulk tank SCC.

Consider as well the possible savings when mastitis is effectively managed. The value of increased milk sales from reduced mastitis more than offset the costs of an effective control program. (Table 3.)

Table 2. Estimated infection prevalence and losses in milk production associated with elevated bulk tank SCC.

Bulk Tank SCC (1,000's/ ml) in Herd	Percent Infected Quarters	Percent Production Loss*
200	6	0
500	16	6
1000	32	18
1500	48	29

*Production loss calculated as a percent of production expected at 200,000 cells ml.
Source: Current Concepts of Bovine Mastitis. National Mastitis Council, 1996.

Table 3. Estimated annual savings from an effective mastitis control program.

National Mastitis Council Study (Table 1):	
Production per cow (+1,069 lb @ $12 cwt)	$121.08
Clinical mastitis reduced 40%	
Discarded milk $10.45 x 40%	4.18
Total Return	$125.26
Mastitis Control Costs (per cow annually)	
Teat dip	$10.00
Dry cow medication	$4.00
Paper towels	$10.00
Total Cost	$24.00
Net Return to mastitis control (per cow annually)	$101.26

Effects on Milk Production, Composition and Quality

Mastitis reduces milk yield and alters milk composition. The magnitude of these changes in individual cows varies with the severity and duration of the infection and the causative microorganisms. Mastitis is almost always caused by bacteria. These microorganisms produce toxins that can directly damage milk-producing tissue of the mammary gland, and the presence of bacteria initiates inflammation within the mammary tissue in an attempt to eliminate the invading microorganisms. The inflammation contributes to decreased milk production and is primarily responsible for the compositional changes observed in milk from infected quarters and cows. In general, compositional changes involve an increase in blood components present in milk and a decrease in normal milk constituents.

Production

The Dairy Herd Improvement Association (DHIA) has adopted an SCC scoring system that divides the SCC of compositive milk into 10 categories from 0 to 9 known as linear scores. The DHIA programs determine the SCC on each milking cow each month and report either the SCC or the linear score. Linear scores can be used to estimate production losses, but the average linear score for the lactation most accurately reflects reduced milk yield. Cows with higher lactation average SCC scores produce less milk (Table 4).

Production losses in older cows are about double those of first lactation cows. Determining the exact amount of milk lost at a specific SCC or linear score or for any one cow is not possible. However, the fact remains that elevated SCC results in major losses to dairy producers, and elevated SCC is almost always due to the presence of intramammary infection.

Table 4. **Somatic cell counts as they relate to estimated milk losses.**

Lactation Average Linear SCC Score[#]	CMT (Score)	WMT (mm)	Somatic Cell Count (cells/ml)	Milk Loss (%)	Estimated Milk Production Loss Per Cow/Year* (lb)
2	Negative	--	50,000	---	---
3	Negative	2	100,000	3	-400
4		5	200,000	6	-800
	Trace	8	300,000	7	-1,000
5		10	400,000	8	-1,200
		12	500,000	9	-1,300
	1	14	600,000	10	-1,400
		16	700,000		-1,500
6		18	800,000	11	-1,600
		20	900,000		-1,650
		21	1,000,000	12	-1,700
	<2	24	1,200,000	>12	-1,700
7		29	1,600,000		-2,000

*Based on 14,000-15,000 lb average/cow/year, lasted in ≥2.
[#] Linear score calculation from SCC. Example: SCC = 2000,000/ml.
CMT Interpretation:
Negative - Mixture remains liquid with no evidence of the formation of a precipitate.
Trace - A slight precipitate or small flakes form and then disappear.
1 (weak positive) - A distinct precipitate forms.
2 (distinct positive) - The mixture thickens immediately with some gel formation.
Source: Dairy Herd Improvement Association and Philpot (1984).

Linear score calculation from the SCC.

Example: SCC = 200 (i.e., 200,000/ml)

1. Divide the reported SCC by 100.*	**200/100 = 2**
2. Determine the natural log (In).	**In 2 = .693147**
3. Divide this value by .693147.	**.693147/.693147 = 1**
4. Add “3" to the result.	**1 + 3 = 4 linear score**

*If SCC is expressed as 1,000s of cells/ml, divide by 100,000: (200,000/ 100,000) = 2.

Composition

Changes in milk composition accompany the increase in SCC following infection of the mammary gland. Table 5 compares the composition of normal, low SCC milk with milk having a high SCC. These comparisons frequently are made between high and low SCC milk from opposite quarters of the same cow to reduce cow to cow variation. Elevated SCC is associated with a decrease in the content of lactose and fat in milk because of a reduced ability of the mammary gland to produce these components. Some studies have shown no change in fat percentage, yet total fat production declines with the decrease in milk production.

Although there may be little change in the total protein content as a result of subclinical mastitis, there are marked and significant changes in the types of proteins present. The major milk protein is casein. This protein has high nutritional qualities and is very important in cheese manufacturing. Casein content of milk with a high SCC is reduced, but lower quality whey proteins increase in concentration, resulting in a similar total protein content. The lower quality whey proteins are blood serum proteins such as serum albumin, immunoglobulins, and transferrin, which increase in milk as a result of the destruction of membranes that normally prevent blood serum proteins from entering milk.

Sodium and chloride increase in high SCC milk due to increased passage of these minerals from blood into milk. Potassium, normally the predominant mineral in milk, declines due to its passage out of milk to lymph between damaged secretory cells. Most of the calcium in milk is associated with casein, and disruption of casein synthesis results in reduced calcium levels in milk from mastitic cows. These alterations in mineral content affect the pH and conductivity of milk. The pH of normal milk is generally around 6.6, but may increase to 6.9 or higher in milk from mastitic quarters.

Other important compositional changes include increases in enzymes originating from damaged mammary tissue, the blood stream, or milk somatic cells. Many of these enzymes negatively impact milk quality. An increase in the enzyme lipase can raise the content of free fatty acids, which produce off-flavors in milk from mastitic cows. An additional example is the enzyme plasmin, which may double in concentration in high SCC milk. Plasmin attacks casein and can markedly reduce the casein content, resulting in lower yields of cheese and other manufactured products and off-flavors in milk.

Quality

Mastitis not only reduces dairy producer profits but also results in important and costly losses to processors due to poor quality milk. Reduced quality is detected with herd milk at 400,000 cells/ml. A variety of dairy products are affected, including cheeses, powdered milk, fermented products, and fluid milk. Progressive milk plants pay on milk quality for obvious reasons, but quality premiums also pay big dividends to producers, as shown in Table 6. For example, a 100-cow herd averaging 50 lbs milk per cow per day and receiving $0.25 per hundredweight premium would get $375 more per month in milk receipts.

Table 5. **Changes in milk composition associated with an elevated SCC.**[1]

Constituent	Normal Milk	Milk With High SCC	Percentage of Normal
	%	%	%
Solids-Not-Fat	8.9	8.8	99
Fat	3.5	3.2	91
Lactose	4.9	4.4	90
Total Protein	3.61	3.56	99
Total Casein	2.8	2.3	82
Whey Protein	.8	1.3	162
Serum Albumin	.02	.07	350
Lactoferrin	.02	.10	500
Immunoglobulins	.10	.60	600
Sodium	.057	.105	184
Chloride	.091	.147	161
Potassium	.173	.157	91
Calcium	.12	.04	33

[1]Example of compositional changes found in various studies.

Table 6. **Dollar return per month in a 100 cow herd with quality premiums of $0.10 to $0.50/cwt and average lbs of milk/cow/day from 30 to 70 lbs.**

Premium per cwt milk	Quality Premium Return per 100 cows per month (30 days)				
$0.50	$450	$600	$750	$900	$1,050
$0.45	$405	$540	$675	$810	$945
$0.40	$360	$480	$600	$720	$840
$0.35	$315	$420	$525	$630	$735
$0.30	$270	$360	$450	$540	$630
$0.25	$225	$300	$375	$450	$525
$0.20	$180	$240	$300	$360	$420
$0.15	$135	$180	$225	$270	$315
$0.10	$90	$120	$150	$180	$210

Source: W.L. Crist, et al. Mastitis and Its Control. Univ. of Kentucky.

Development of Mastitis

A basic knowledge of mammary gland anatomy and physiology is necessary to understand how mastitis develops. The interior of each quarter is composed of a teat cistern, gland cistern, milk ducts, and glandular tissue (Figure 2-A). The glandular tissue or secretory portion contains millions of microscopic sacs called alveoli (Figure 2-B). Each alveolus is lined with milk-producing epithelial cells and is surrounded by muscle cells that contract and squeeze milk from the alveolus during milking. Blood vessels bring nutrients to each alveolus where epithelial cells convert them into milk.

Between milkings, milk accumulates in the alveolar spaces, milk ducts, and cisterns. During milking, the accumulated fluid is removed through the teat ducts.

Invasion of the Udder

Mastitis results once bacteria pass through the teat duct and multiply in milk-producing tissues. Microorganisms breach the teat duct in several ways. Between milkings, microorganisms may pass through the teat duct by multiplying inside the duct, or by physical movement resulting from pressure placed on the teat end as the cow moves about. During machine milking, microorganisms may be propelled into or through the teat duct into the teat cistern.

The potential for invasion is greatly increased by bacteria that reside in or colonize the teat duct. Such colonizations occur in both lactating and dry cows, and the colonizing bacteria may survive for months, serving as sources of bacteria for infecting the gland. The practice of dipping teats with an effective bacteriacide both before and after each milking greatly reduces teat duct colonization.

To better understand the important difference among mastitis causing organisms, the following list summarizes contagious and environmental mastitis.

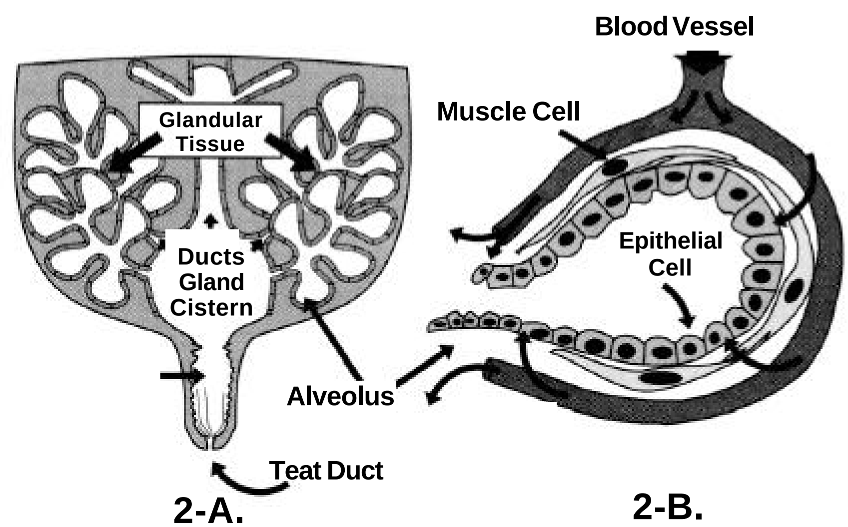

Figure 2.

Structure of the mammary gland showing teat and gland cisterns, milk ducts, and glandular tissue (A). Glandular tissue is made up of many small microscopic sacs called alveoli that are lined by milk-producing epithelial cells (B). There are millions of alveoli within each mammary gland.

Contagious Versus Environmental Mastitis, Understanding the Difference

Controlling Contagious Mastitis

Caused by:
Streptococcus agalactiae (S. agalactiae)
Staphylococcus aureus (S. aureus)
Streptococcus dysgalactiae (S. dysgalactiae)

Primary source:
Udders of infected cows.

Method of spread:
From infected quarters to other quarters and cows primarily at milking time.

Indicators of problem:
Bulk tank somatic cell count (SCC) above 300,000 cells/ml.

DHIA SCC score above 3.2.

More than 15% of cows with a DHIA SCC score of 5 or greater.

Frequent flare ups of clinical mastitis, often in the same cows.

Bacterial culturing of cows shows *S. agalactiae* and/or *S. aureus* infections.

Control recommendations:
Develop program to prevent the spread of bacteria at milking time.

Eliminate existing infections by treating all cows at drying off and culling chronic cows.

Goals:
Eradicate *S. agalactiae* from the herd.

Reduce *S. aureus* infections to less than 5% of the cows in the herd.

Controlling Environmental Mastitis

Caused by:
Coliforms
- *Escherichia coli*
- *Klebsiella pneumoniae*
- *Klebsiella oxytoca*
- *Enterobacter aerogenes*

Environmental streptococci
- *S. uberis*
- *S. bovis*
- *S. disgalactiae*
- *Enterococcus faecium*
- *Enterococcus faecalis*

Primary source:
The environment of the cow.

Indicator of problem:
High rate of clinical mastitis, usually in early lactation or during hot weather. Somatic cell count may be low (less than 300,000).

Control recommendations:
Reduce the number of bacteria to which the teat end is exposed.

Improve cleanliness of cow surroundings, especially in late dry period and at calving.

Improve prepping procedures to ensure clean, dry teats are being milked.

Goal:
Reduce clinical mastitis to less than 3% of the milking cows/month.

Refer to the following discussion for more detail on the organisms.

Controlling Contagious Mastitis

Staphylococcus aureus infections remain the largest mastitis problem on North Dakota dairy farms. Cure rate with antibiotic therapy during lactation is very low. Many “staph” cows become chronic and have to be culled.

Streptococcus agalactiae responds well to antibiotic therapy and can be eradicated from dairy herds with good mastitis control practices including teat dipping and dry cow treatment.

Streptococcus dysgalactiae may live almost anywhere: in the udder, rumen, and feces, and in the barn. They can be controlled with proper sanitation and are moderately susceptible to antibiotics.

Prevention - Improved milking procedures:

- Milk clean, dry teats.
- Keep liner slips to a minimum.
- Teat dip with an effective germicidal teat dip. Maintain milking system.

Eliminating infections:

- Treat all quarters of all cows at drying off with antibiotic products specifically designed for dry cow therapy.
- Cull chronically infected cows.
- Steps to follow to control mastitis and lower somatic cell count:
- Teat dip.
- Dry cow treat.
- Practice proper milking procedure.
- Use properly functioning milking system.
- Maintain clean, dry environ ment for the cows.
- Cull chronic mastitis cows. Use DHIA SCC program to monitor mastitis in the herd.

Controlling Environmental Mastitis

Prevention:

- Reduce the number of bacteria to which the teat end is exposed.

Environment:

- Cow environment should be as clean and dry as possible.
- Cow should not have access to manure, mud, or pools of stagnant water.
- Dry cow environment is as important as lactating cow environment.
- Calving area must be clean.
- Properly design and maintain free stalls.

Bedding:

- Bacteria numbers in bedding depends on available nutrients, amount of contamination, moisture, and temperature.
- Inorganic materials (such as crushed limestone or sand) are low in nutrients and moisture, and thus bacteria.
- Finely chopped organic bedding (such as sawdust, shavings, recycled manure, pelleted corncobs, various seed hulls, chopped straw) are frequently high in bacteria numbers.

Teat dipping:

- Post milking teat dipping with a germicidal (germ-killing) dip is recommended.
- Controls the spread of conta gious mastitis.
- Exerts no control over coliform infections.
- Barrier dips are reported to reduce new coliform infections; however, they do not appear to be as effective against environmental streptococci and the contagious pathogens.
- Attempts to control environ mental mastitis during the dry period, using either germicidal or barrier dips, have been unsuccessful.

Dry cow therapy:

- Recommended for all quarters of all cows at drying off.
- Helps control environmental streptococci during the early dry period.
- Has little or no value in controlling coliforms.
- Not effective during the period prior to calving.

Backflushing milker claws between cows:

- Will not control environmental mastitis.

Proper milking procedure:

- Proper milking procedure is important.
- Wash teats, but not the udder.

- Clean and dry teats before attaching the milking machine.
- Milking wet udders will likely increase mastitis.

Predipping:

- A germicidal teat dip reduces environmental mastitis during lactation by 50%.
- Be sure teat dip is removed from teats before attaching milking machine to prevent contamination of the milk.

Milking machine:

- Maintain and operate properly.
- Badly functioning milking machines result in frequent liner slips and teat end impacts will increase environmental mastitis.

Nutrition:

- Proper nutrition will reduce the risk of environmental mastitis.
- Adequate levels of Vitamin E and selenium reduce the incidence of environmental mastitis.
- There are conflicting reports whether Vitamin A and ß-carotene influence udder health.
- Ongoing research at the University of Kentucky indicates that copper may play a role in maintaining the immune system in dairy cattle.
- Feed dairy cattle a balanced ration.

Vaccines:

- Not effective in preventing new infections.
- Research on vaccines to reduce *Escherichia coli* and staphylococcal mastitis infections looks promising.

Proper Milking Procedures

Proper milking procedures are important for the prevention of mastitis and for ensuring complete milk removal from the udder.

Cow Movement. Cows should be moved in a quiet, gentle manner. If cows are frightened or hurried, the milk letdown process may be disturbed, so avoid rough handling.

Mastitis Detection. Milking may begin with a check of all quarters for mastitis. It is acceptable to strip milk onto the floor in a milking parlor or flat barn. Any cows that show clinical mastitis should be examined and appropriate action taken. If fore milking is not done, visual checking for inflamed quarters is done by milkers and herd health people.

Udder Preparation. The object of udder preparation is to ensure that clean dry udders and teats are being milked. Single service paper towels or washed and dried cloth towels may be used.

Premilking Teat Dip. The procedure for predipping involves washing teats with water and a sanitizer. The teats are then dried with an individual towel and dipped or sprayed with the sanitizer. A 30-second contact with sanitizer is needed to kill organisms. Then the sanitizer is wiped dry with the towel. The cows are milked and teats are dipped with the same type of sanitizer to prevent chemical reactions that could cause irritation to teats.

Predipping may be beneficial in reducing mastitis, but the actual dipping, dip contact time, and wiping with a towel increase the total milking time. If the dip is not wiped off, excessive chemical residues in milk may occur. If contact time is not sufficient, then it is a very expensive premilking regime.

Milking Unit Attachment and Detachment. To attach the milking unit to the teats, apply the cluster allowing a minimum of air admission and adjust to prevent liner slip. Air entering the unit may cause the propulsion of mastitis organisms from one infected teat into a noninfected teat. This may also happen when one teat cup is removed before the others.

Machine stripping usually is not needed on dairy cows. Machine stripping should not take more than one minute, and no air should be allowed to enter the teat cups while this is being done. A downward force applied to the cluster while massaging the udder with the other hand is all that is needed.

Following milk-out, the machine should be removed only after the vacuum to the teats is shut off. This is accomplished most commonly by use of a vacuum shut off valve or milk hose clamp which prevents the backjetting of bacteria from one teat to another.

Use of Backflush. Backflushers have been developed to sanitize the liners and claws between milkings. Most units on the market have four or five cycles. The first cycle is a water rinse, followed by an iodine or similar sanitizer rinse, a clear water rinse, and positive air dry cycle.

Research has demonstrated that backflushers do reduce the number of bacteria on the liners between cows, but do not reduce the number of bacteria on teats. Backflushers also may stop the spread of contagious organisms, but this can also be accomplished at a much lower cost by teat dipping. There is no effect on environmental pathogens that are encountered between milkings.

Teat dips are effective against all mastitis organisms. They have been shown to effectively reduce mastitis caused by *S. aureus* and *S. agalactiae*, the most common types of mastitis found.

There seems to be much controversy about the effectiveness of teat dipping on environmental pathogens *E. coli* and *S. uberis*. Some research has shown that teat dipping does not control these organisms. These pathogens are found in the cow's surroundings; if there is udder-deep mud, the teat dip will be removed and a new infection may occur.

There are many effective teat dips, including iodine at 0.1%, 0.5%, and 1.0%, and chlorhexidine at 0.5%. Also, although it is not labeled for teat dipping, hypochlorite at 4.0% with a sodium hydroxide content less than 0.05% was effective in field trials. There are many more teat dips on the market that are effective in preventing new infections. Effective coverage of the teats is more important than the type of dip being used.

If contagious bacteria, *S. agalactiae, S. dysgalactiae, S. aureus*, or Mycoplasma, is present in your herd you must dip the whole teat to the base of the udder to stop the spread. Wand sprayers are acceptable for herds that have environmental mastitis, since teat colonization is not a factor. Hand-held spray bottles are the most ineffective method of getting proper coverage of dip on the cow's teats, so they should not be used. Dip cups, on the other hand, give the best coverage.

Dry Cow Therapy. Dry cow treatment is administered after the last milking of the cow before the dry period. Care must be taken to scrub the teat end with cotton and alcohol before infusion and to use teat dip after infusion.

There are many antibiotics available for dry cow therapy. High levels of penicillin and dihydrostreptomycin, the cloxacillins and other products specifically for dry treatment are effective.

Dry period therapy has been accepted because antibiotics can be put into a slow release base that allows them to stay in the udder longer. They are not constantly being milked out of the udder as is the case with lactation therapy. Antibiotics can be given in higher quantities because there is no concern for milk levels and antibiotic residues.

While dry treatment is very effective, it must be administered properly and dry cows must have favorable environmental conditions. Teat ends must be scrubbed clean with cotton alcohol pads before injecting the dry treatment. If the teat ends are not cleaned properly, you may inject very high numbers of bacteria into the udder which would overwhelm the antibiotic just administered. Unsanitary treatment procedures cause rather than eliminate mastitis.

Management of dry cows is very important in mastitis control. If dry cows are exposed to muddy or dirty conditions, risk of mastitis will increase. This is especially true at calving time; cows are under much stress during this period. If an udder is exposed to wet dirty conditions, mastitis will increase. If you believe that your dry cow therapy program is ineffective, it may be because of poor treatment procedures and/or improper management of the cows during the dry period and at calving.

Milking Machine Inspection and Maintenance Checklist

Before each milking:

Check

- ❏ vacuum controller
- ❏ milking vacuum
- ❏ hoses and teatcup liners for holes or tears
- ❏ pulsators
- ❏ air admission holes in claw or tailpiece of liner

Weekly (or every 50 hours of operation):

Set aside one day each week to perform these checks, such as every Monday morning.

Check

- ❏ and clean vacuum controller
- ❏ and clean pulsator filters
- ❏ belts on vacuum pumps
- ❏ oil reserve on vacuum pump
- ❏ if it is time to change liners (every 1,000-2,000 milkings, or as recommended)
- ❏ clean moisture trap
- ❏ automatic take off equipment (especially vacuum shut off)

Monthly (or every 250 hours):

Set aside one day each month to perform these checks, such as the first Monday of each month.

Check

- ❏ and clean the pulsators
- ❏ and clean vacuum pulsation lines
- ❏ vacuum pump(s)
  check belts for wear and tension
  clean screens
  change filters on vacuum pump tank
  change oil if needed
- ❏ change liners if it is time

Dealer checks and service (every 6 months or 1,250 hours):

Checks to be made:	Equipment needed:
❏ air delivery by vacuum pump	air flow meter
❏ reserve air flow (*remaining pump capacity with units operating but not on cows*)	air flow meter
❏ pulsator rate (*pulsations per minute*)	stop watch or clock
❏ pulsator function and ratio	vacuum recorder
❏ vacuum level	vacuum gauge
❏ line voltage	voltmeter

Maintenance items:

- ❏ Check all gaskets, flappers, "O" rings, and caps which come in contact with milk. Replace if worn.
- ❏ Clean all electric pulsator selectors and activators. Check all solenoids and coils. Clean all plungers and vacuum lines.
- ❏ Overhaul pneumatic pulsators. Repair milk supports, milker units, etc.

Every year (or 2,500 hours of use):

- ❏ Change all solenoid coils, plungers, hoses, diaphragms, caps, gaskets, flappers, and rubber vacuum connectors.
- ❏ Check electric timer controls, switches, motors, and parts. Grease all bearings.
- ❏ Check milk pump seal, rubber spring, and clearances. Change gaskets.

Every two years (or 5,000 hours of use):

- ❏ Recondition entire system, including all motors, pumps, selectors, timers, and starters.
- ❏ Replace all rubber coils, hoses, gaskets, "O" rings, springs, and plungers. Clean entire pipeline system.

For more information on milking machines, refer to, "The Modern Way to Effective Milking," published by the Milking Machine Manufacturers Council of the Farm and Industrial Equipment Institute, 410 N. Michigan Avenue, Chicago, IL 60611-4251.

Culling. Culling cows for mastitis is effective in eliminating mastitis in the herd. Cows that have been treated many times in a single lactation are prime candidates for culling, as they may no longer be profitable because of discarded milk and antibiotic costs. it is usually more profitable to carry out preventive mastitis control procedures and cull only old chronic cows rather than try to control mastitis by routine culling.

Proper Treatment Procedures

In every program, some medication is required, plus dry cow treatment protocol. This is especially important with intramammary infusions. Extreme care must be taken whenever anything is being infused into a cow's udder. Careless treatment procedures can result in udder infections resistant to treatment. Approach treatment in the same way a surgeon approaches surgery.

- Wash hands with soap and water.
- Wash teats and udder in sanitizing solution.
- **Thoroughly** dry teats and udder with individual towels.
- Dip teats in an effective germicidal teat dip.
- **Allow 30 seconds of contact time** before wiping off teat dip with an individual towel.
- Thoroughly scrub the teat end with a cotton swab soaked in alcohol. If all four quarters are being treated, start by cleaning the teat farthest from you and work toward the closest teat.
- Use commercial antibiotic products in single dose containers formulated for intramammary infusion. For dry cow therapy, use commercial antibiotic products specifically formulated for dry cow therapy in single dose containers. Treat teats nearest to you first, then those farthest away to prevent contaminating clean teat ends.
- Insert only the tip of the canula into the teat end. Do not allow the sterile canula to touch anything prior to infusion.
- After infusion, remove canula, squeeze teat end with one hand, massage antibiotic up into the quarter with the other hand.
- Dip teats in an effective germicidal teat dip after treatment.

How to Collect Milk Samples

Even the most successful milking management program needs to culture samples when problems arise. Positive identification of invading organisms can speed up solutions to difficult challenges. When taking samples, it is imperative that you take a sample that is not contaminated for accurate lab analysis.

- Label sterile tubes and fill out forms ahead of time. (Tubes with screw caps are preferred.)
- Wash hands in soap and water.
- Wash teats in sanitizing solution.
- Dry teats with individual towels.
- Discard one or two squirts of milk from each teat.
- Dip teats in germicidal teat dip.
- Allow 30 seconds of contact time before wiping off teat dip with an individual towel.
- Thoroughly scrub the teat end with a cotton swab soaked in alcohol. If a composite sample is being taken from all four quarters, start with the teat farthest from you and work toward the closest teat. Use a clean swab on each teat.
- Open the sterile tube under the teats. Hold it at an angle so that foreign material cannot fall into the opening. Do not allow anything to come in contact with the mouth of the tube. Collect one or two squirts of milk from each quarter, starting with the closest quarters and working toward the ones farthest away.
- Close the container before removing it from beneath the teats.
- Refrigerate samples until they reach the lab. If samples will not reach the lab within 24 hours, they should be frozen and kept frozen until they reach the lab.

NDSU Extension Service, North Dakota State University of Agriculture and Applied Science, and U.S. Department of Agriculture cooperating. Sharon D. Anderson, Director, Fargo, North Dakota. Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. We offer our programs and facilities to all persons regardless of race, color, national origin, religion, sex, disability, age, Vietnam era veterans status, or sexual orientation; and are an equal opportunity employer. 1500-4-97

This publication will be made available in alternative format upon request to people with disabilities (701) 231-7881.

AS-1129