AS1129 (Revised)

Mastitis Control Programs

Bovine Mastitis and Milking Management

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

To simplify understanding of mastitis, you'll need to consider that three major factors are involved in this disease: the microorganisms that cause it, the cow as host and the environment, which can influence the cow and the microorganisms. (Figure 1)

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

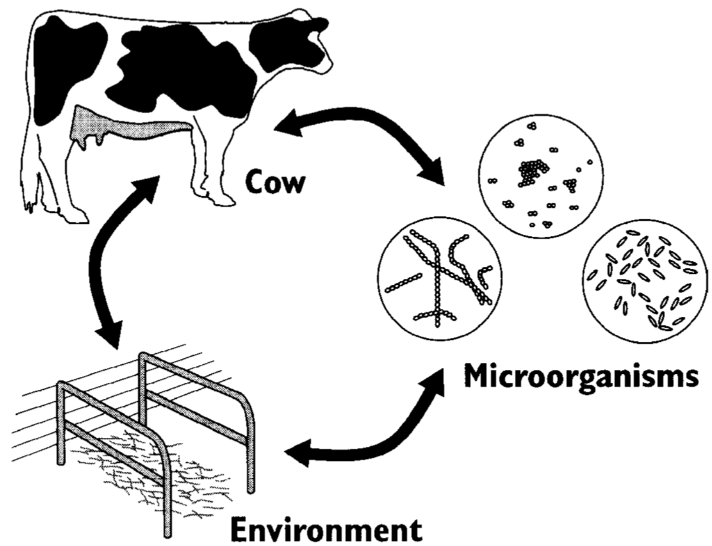

Figure 1

Cows contract udder infection at different ages and 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 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 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.

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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:

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

Bacteriological culturing of milk will detect bacteria in the milk.

Clinical mastitis causes the greatest financial loss to dairy farmers through lowered milk production

For every clinical case of mastitis, 15 to 40 subclinical cases will occur.

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.

The bulk tank SCC gives an indication of the level of subclinical mastitis and the loss of milk production in a herd due to mastitis.

Losses to mastitis are estimated at more than $200 per cow annually. The various contributors to direct mastitis losses per cow are listed in Table 1.

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

Source of Loss	Loss per Cow ($)	Percent of Total (%)
Decreased milk	140	70
Discarded milk	20	10
Replacement cost	16	8
Decreased sale value	10	5
Drug therapy	8	4
Veterinary service	4	2
Extra labor	2	1
TOTAL	**$200**	**100.0**

Economic Loss

If we assume the same milk price and this value is multiplied by the total number of milking cows (9 million head), the total annual cost of mastitis is about $1.8 billion. This is approximately 10 percent 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 withheld milk 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, first consider 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 SCCs.

Consider as well the possible savings when mastitis is managed effectively. The value of increased milk sales from reduced mastitis more than offsets 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 (1,000s/ml) in Herd	Percent Infected Quarters	Percent Infection Level	Percent Production Loss*
200	6	4	0
500	16	11	6
1,000	32	21	18
1,500	48	32	29

*Infection level (cows) is based on the assumption that the average infected cow is infected in 1½ quarters.
**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 (+1,050 lb @ $12 cwt)	$126.00
Clinical mastitis reduced 40%	
Discarded milk $24 x 40%	10.00
Total Return	$136.00
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)	$112.00

A web-based tool will be available to calculate your costs at:
www.google.com/url?sa=t&rct=j&q=estimated%20annual%20losses%20due%20to%20mastitis&source=web&cd=11&ved=0CEgQFjAAOAo&url=http%3A%2F%2Fwww.ansci.umn.edu%2Fdairy%2FQuality_Counts_2012%2Fspreadsheets%2FS-MP-3_Losses_due_to_mastitis-Fetrow2011.xlsx&ei=qgPNT9KIIqPz0gHU_c3SDg&usg=AFQjCNHIr0ivY2heh9s7PcDM_GiZktJgjw

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 almost always is 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 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 composite 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 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 SCCs result in major losses to dairy producers, and elevated an 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- to 15,000-lb average/cow/year, lasted in >2.
Linear score calculation from SCC. Example: SCC = 200,000/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.

Linear score calculation from the SCC.

Example: SCC = 200 (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 SCCs are 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 the total protein content may change very little as a result of subclinical mastitis, changes in the types of proteins present are marked and significant.

The major milk protein is casein. This protein has high nutritional qualities and is very important in cheese manufacturing. The 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 the 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 about 6.6, but it 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 reduce the casein content markedly, 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, including cheeses, powdered milk, fermented products and fluid milk, are affected. 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 pounds of milk per cow per day and receiving a $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 10 to 50 cents/cwt and average of 30 to 70 pounds of milk/cow/day.

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
Average lb. Milk/cow/day	30	40	50	60	70

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

Development

Somatic cell programs offered by the Dairy Herd Improvement Association (DHIA) provide a tool to monitor the herd and individual mammary health status. The programs offer a way to identify clinical or subclinical mastitis so associated milk losses can be calculated and/or measures initiated to correct the cause of the somatic cell count (SCC) rise. Increased SCCs have been associated with decreased milk and fat production. These losses occur even with low SCC readings of 200,000 cells/ml and below. The estimated milk lost for varying SCC scores is shown in Table 7.

Table 7. Milk production losses for various SCC scores.

SCC (000s/ml)	Pounds/ day	Pounds/ lactation
50	0	0
100	1.5	400
200	3.0	800
400	4.5	1,200
800	6.0	1,600
1,600	7.5	2,000
3,200	9.0	2,400
6,400	10.5	2,800

If the herd size is 75 cows and the SCC score is 800,000, the estimated loss in milk production is 120,000 pounds per year. With a milk price of $18 per hundredweight, this lost milk amounts to a gross income of $21,600 per year. Not only are you losing income from the sale of milk, but you also may be losing a premium for not selling high-quality milk, as well as income from other mastitis-related losses.

An excellent way to monitor a herd's SCC score and identify potential problem cows and management practices is to enroll in the DHIA-SCC testing program. This program enables the producer to monitor not only each individual cow's SCC level, but it also helps in uncovering potential herd management problems. An SCC report is mailed monthly to each producer enrolled in the program. The report has seven components.

Lactation Averages

The report stratifies the average SCC score for three lactation groupings: 1, 2, 3 and greater. This part of the report shows if a problem is occurring with animals in a certain lactation. If heifers have a serious SCC problem, the heifer-rearing facilities may be dirty or wet, or lack adequate ventilation, or the freshening area for heifers may be harboring bacteria that is causing serious contamination. If the older animals are presenting the problem, perhaps: 1) cows are not being dry-treated, 2) housing and dry lots need to be cleaned or 3) calving stalls need to be cleaned and disinfected. You normally can expect the older animals to have slightly higher SCC scores than heifers.

Weighted Herd Average by Sample Day

This listing shows the average SCC for your herd weighted by the amount of milk each cow produced. This report shows a rolling six-month average on your herd's SCC level. Use this information to monitor any management changes made during the last six months. It also may indicate whether the herd's SCC is being affected by factors of which you are not aware. This report also shows if SCC scores increase during certain seasons of the year. If you have a marked increase for a given season, examine the facilities to see if you have excess moisture in certain areas, poor sanitation, lack of shade or other potential problems that should be avoided or corrected before next year.

SCC Summary

This gives a distribution of the number of cows regardless of lactation number that fall into five SCC levels below 100,000 to above 800,000 cells. This immediately lets you know where your cattle rank. This section also allows you to compare your herd with the average of all herds in the midstate processing area. Remember, one or two cows can influence your herd's SCC score greatly, so be certain to look at this summary to aid in interpreting your overall score.

Days in Milk SCC Average

This section gives the average SCC score for all cows at different stages of lactation. The scores on cows fresh under 50, 50-100, 101-200, 201-300 and more than 300 days are listed. By using this grouping, you can see if you are having problems early, in the middle or during the latter part of the lactation. If a cow's SCC scores are highest during the early stages of lactation, check freshening areas for possible problems. A clean, dry, well-ventilated freshening area is essential for low SCC scores. If the majority of scores are high, examine milking procedures, milking equipment, sanitation practices and treatment procedures, and check for stray voltage.

Linear Score

This section lists your SCC score in a linear form. To provide more uniform SCC reporting, the Daily Herd Improvement Association has adopted a uniform scoring method called the linear score. The linear score divides the somatic cell count into 10 categories from 0 through 9.

Animals Over 400,000 Cell Count

All animals that have cell counts in excess of 400,000 are listed under this section. These cows should have quarter samples taken and checked closely because their cell counts indicate serious clinical or subclinical mastitis problems. Also, included along with the cow's SCC score is the percent of the overall herd SCC score that each cow is contributing. Often you can reduce the SCC level greatly by simply culling a few cows. The quickest and easiest way to reduce SCCs is simply to cull the top SCC cows. To reduce high SCCs permanently, getting to the root of the problem is necessary.

Individual Animal Report

The DHIA lists the SCC scores on all cows for the last six months. This is an excellent way to monitor cattle to spot those animals with chronic problems. If a cow always has a high SCC score, culture her milk to see if a particular pathogen is causing the problem. Once a specific pathogen is identified, establish and follow your veterinarian's treatment program. The DHIA-SCC report can be a valuable aid in identifying some of the major causes of mastitis. The common causes of mastitis that cause high cell counts are:

- Faulty milking procedures
- Milking equipment
- Poor sanitation
- Poor facilities
- Stray voltage
- Specific pathogen infection
- Long lactations
- A high proportion of older cows

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 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 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.

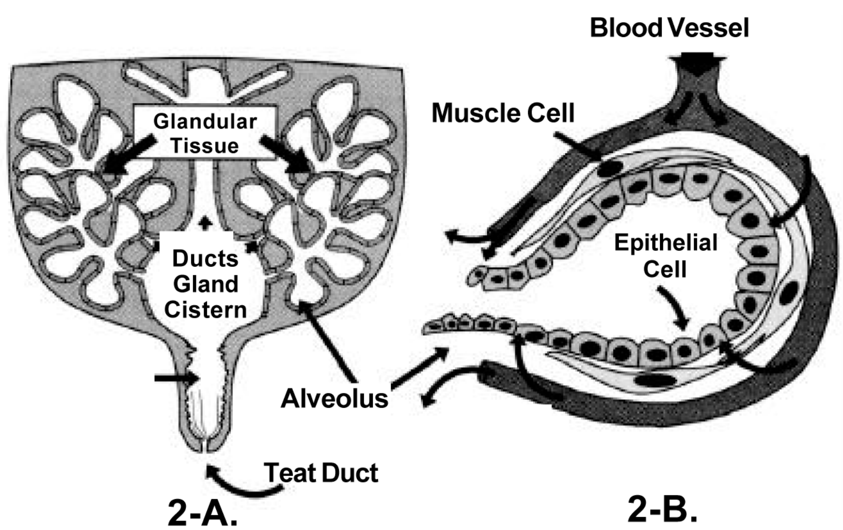

Figure 2.

Structure of the mammary gland showing teat and gland cisterns, milk ducts and glandular tissue (A). Glandular tissue is made up of many microscopic sacs called alveoli that are lined by milk-producing epithelial cells (B). Millions of alveoli are in 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 percent 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 percent 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 percent 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. The 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 teat dip with an effective germicidal teat dip.
- Maintain the 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 for controlling mastitis and reducing somatic cell counts:

- Teat dip.
- Dry-cow treat.
- Practice proper milking procedure.
- Use a properly functioning milking system.
- Maintain a clean, dry environment for the cows.
- Cull chronic mastitis cows.
- Use the 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:

- Keep the cow environment as clean and dry as possible.
- Prevent sows from having access to manure, mud or pools of stagnant water.
- Know that the dry-cow environment is as important as the lactating-cow environment.
- Keep the calving area clean.
- Properly design and maintain free stalls.

Bedding:

- Bacteria numbers in bedding depend 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 contagious 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 environmental 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 important:

- Wash teats, but not the udder.
- Clean and dry teats before attaching the milking machine.
- Milking wet udders likely will increase mastitis.

Proper Milking Procedures

Proper milking procedures are important for the prevention of mastitis and 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. Stripping milk onto the floor in a milking parlor or flat barn is acceptable. Any cows that show clinical mastitis should be examined and appropriate action taken. If foremilking is not done, milkers and herd health people should visually check for inflamed quarters.

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 pre-dipping involves washing teats with water and a sanitizer. Then dry the teats with an individual towel and dip or spray them with the sanitizer. The teats need to have a 30-second contact with sanitizer to kill organisms. Then wipe the sanitizer dry with the towel. Milk the cows and dip the teats with the same type of sanitizer to prevent chemical reactions that could cause irritation to teats.

Pre-dipping 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 this is a very expensive pre-milking 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 also may 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 using a vacuum shut-off valve or milk hose clamp, which prevents the backjetting of bacteria from one teat to another.

Pre-dipping:

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

Milking machine:

- Maintain and operate It properly because 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.
- Reports differ whether vitamin A and ß-carotene influence udder health.
- Ongoing research at the University of Kentucky indicates 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

Use of Backflushers: 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 also can be accomplished at a much lower cost by teat dipping. Backflushing has 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.

Considerable controversy surrounds 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 mud is udder deep, the teat dip will be removed and a new infection may occur.

Many effective teat dips, including iodine at 0.1 percent, 0.5 percent and 1 percent, and chlorhexidine at 0.5 percent, are available. Also, although hypochlorite at 4 percent with a sodium hydroxide content less than 0.05 percent is not labeled for teat dipping, it was effective in field trials.. 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)* are 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 because 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. Take care to scrub the teat end with cotton and alcohol before infusion and to use teat dip after infusion.

Many antibiotics are 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 milk levels and antibiotic residues are not concerns.

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, the 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, that 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, such as every Monday morning, to perform these checks.

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)
- ❑ and clean moisture trap
- ❑ automatic take off-equipment (especially vacuum shut off)

Monthly (or every 250 hours):

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

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 six 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 the entire system, including all motors, pumps, selectors, timers and starters.
- ❑ Replace all rubber coils, hoses, gaskets, "O" rings, springs and plungers. Clean the 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 because they no longer may be profitable as the result of discarded milk and antibiotic costs. Carrying out preventive mastitis control procedures and culling only old, chronic cows usually is more profitable than trying to control mastitis by routine culling.

Proper Treatment Procedures

In every program, some medication, plus dry-cow treatment protocol, is required. This is especially important with intramammary infusions. Take extreme care whenever infusing anything 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 your hands with soap and water.
- Wash teats and the udder in sanitizing solution.
- **Thoroughly** dry teats and the 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 the canula, squeeze the teat end with one hand and massage the 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, taking a sample that is not contaminated is imperative for accurate lab analysis. Here are the steps to collecting milk samples:

- Label sterile tubes and fill out forms ahead of time. (Tubes with screw caps are preferred.)
- Wash your hands in soap and water.
- Wash the teats in a 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 the 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 the tube 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 the 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.

For more information, see other NDSU Extension Service publications in the Mastitis Control Programs series:

- "Proper Milking Techniques," AS1126
- "Troubleshooting a Mastitis-problem Herd," AS1128
- "Milk Quality Evaluation Tools for Dairy Farmers," AS1131

For more information on this and other topics, see www.ag.ndsu.edu

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