Mastitis – A Closer Look

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Mastitis is a serious problem that affects many dairy farms. Approximately 30 to 35 percent, or 120,000, of Michigan's dairy cows have some form of mastitis. Mastitis can result in both direct and indirect losses to dairy farmers, including death or early culling of cows, decreased milk production, milk that must be discarded, and increased veterinary costs.

With good mastitis management practices, less than 10 percent of the cows in a dairy herd should have non-clinical mastitis infections, while the clinical infection rate should be limited to 1 case or less per 100 cows per week. This bulletin contains general information about mastitis: what it is, what causes it, how it can be detected, and some of the effects it can have on a dairy herd.

WHAT IS MASTITIS?

Mastitis is an inflammation of the udder, usually caused by microbial infections in one or more quarters of the udder. Mastitis reduces milk production and adversely affects milk quality.

TYPES OF MASTITIS

Mastitis can be classified into two main types: non-clinical (also called subclinical) and clinical. These types can be further classified as acute or chronic.

Non-clinical Mastitis

Non-clinical mastitis, which accounts for 90 to 95 percent of all cases, is the most common form of mastitis. It causes the greatest overall milk losses in most herds. Research has indicated that 30 to 40 percent of all cows in an average herd may have non-clinical mastitis.

Symptoms of non-clinical cases are not outwardly apparent. There are no signs of disease, such as swelling of the mammary gland, or abnormal milk. Milk must be tested to assess whether a non-clinical infection is present. Changes that do occur in milk must be detected through somatic cell counts, analysis of milk composition, a test of milk conductivity, or through positive bacterial cultures of milk from the affected quarter or quarters.

Clinical Mastitis

Clinical mastitis cases can be identified by abnormal conditions of the udder and milk. Milk from cows with clinical mastitis may have a watery or off-color appearance (often brown or amber) and contain flakes and clots. In severe clinical cases, the infected quarters may swell and become hot, hard, and sensitive to touch. The cow may also show signs of sickness, such as fever, depression, and lack of appetite.

Only about 5 to 10 percent of all mastitis cases are clinical (including acute and chronic cases). About 2 to 3 percent of milking cows in an average dairy herd may have clinical mastitis at any one time.

Acute Mastitis (Clinical and Non-clinical)

Acute mastitis cases have a relatively short duration. In an acute case, a cow may appear healthy, then suddenly become sick. Acute clinical cases are usually confined to just one quarter, and the infected quarter may swell and become hot, hard, and sensitive to touch. The cow may also show signs of weakness, depression, fever and loss of appetite, and have a rapid pulse. Because they tend to occur quickly, often with little or no warning, acute cases can be life threatening.

Several species of organisms can cause acute mastitis. However, because there is no way to tell which species is responsible for the infection just by looking at the milk, one or more tests must be run on a milk sample from an infected quarter to determine which organism is responsible.

Acute non-clinical cases do not show visible udder changes or signs of abnormal milk and may spontaneously resolve in a short time, ranging from a few hours to a day.

Chronic Mastitis (Clinical and Non-Clinical)

A chronic mastitis case is a persistent udder infection that exists from many days to months or even years. This type of mastitis will normally begin as a non-clinical case, then develop into a clinical case. A chronic clinical case may seem to disappear completely because of its ability to revert to a non-clinical form, but within time, the clinical form returns. During the clinical phase, milk will continue to show abnormal signs. Many times, *Staphylococcus aureus* is the type of organism responsible for a chronic case.

In chronic non-clinical cases, the infected quarter(s) will show somatic cell counts of 400,000 or higher (linear score of 5 or higher) for two months or longer. Milk from the infected quarter(s) will also culture positive for mastitis-causing organisms, but milk will look normal.

Gangrenous Mastitis (Clinical)

Some strains of mastitis-causing organisms may produce toxins (poisons) that are responsible for the development of a gangrenous form of mastitis. The toxin, usually produced by *Staphylococcus aureus* bacteria, can lead to death of udder tissue by causing blood vessels to constrict, thus preventing tissue cells in the udder from receiving a normal blood supply. The infected quarter becomes cold, off-colored, and insensitive. A line of demarcation forms, which separates the live and dead tissue. Dead udder tissue located below the line is often referred to as "blue bag" because of its dark or bluish-purple color.

A gangrenous quarter may become moist, with a constant dripping of blood-tinged serum from the teat and the skin around the base of the teat. A severe gangrenous mastitis case can result in death of the cow. A less severely infected gangrenous quarter may be sloughed or amputated and the infected cow may recover, though milk production from that cow may be limited in the future.

WHAT CAUSES MASTITIS?

Bacteria or other microorganisms cause mastitis. Bacterial numbers and their ability to infect the cow's udder are influenced by level of farm sanitation, the bacteria's ability to live, or colonize, in or on the teat end, and the susceptibility of the cow to develop mastitis.

The most common bacteria that cause mastitis are *Streptococcus agalactiae, Staphylococcus aureus,* coliform species, *non-agalactiae Streptococci* and other environmental *streptococci,* pseudomonads, and bovine mycotic (yeast) organisms. In some areas of the United States, dairy herds have problems with other types of mastitis-causing organisms, such as mycoplasma. However, no mastitis cases caused by this organism have been reported in Michigan.

Streptococcus agalactiae *(Strep. ag.)*

Strep. ag. lives primarily in the cow's udder and is the most common cause of non-clinical infections. Infections are usually spread during the milking process via contaminated milkers' hands, common wash materials such as rags or sponges, and contaminated teat cup liners. *Strep. ag.* is most often brought onto a dairy farm through purchased cows infected with the bacteria.

Staphylococcus aureus *(Staph. aureus)*

Staph. aureus lives in the udder or on the udder or teat skin and causes many cases of both clinical and non-clinical, chronic mastitis. It can also cause gangrenous mastitis, which can result in the loss of a cow's infected quarter, or the death of the cow. It is usually spread from infected to non-infected cows during the milking process via contaminated teat cup liners, common wash rags or milkers' hands. In some herds, it is not uncommon to find up to 30 percent or more of lactating cows with two or more *Staph. aureus*-infected quarters.

Although *Staph. aureus* is probably the most prevalent cause of Staph-related mastitis, recent research has indicated that many other species of *staphylococcus* are capable of causing mastitis.

Coliform species

There are three main types of coliform bacteria that cause mastitis: *Escherichia coli, Enterobacteria* and *Klebsiella pneumoniae.* Coliform bacteria live in manure, polluted water, and contaminated bedding. When cows bed down in these contaminated areas, infectious coliform organisms can enter the cows' teats. Direct cow-to-cow transfer is unlikely. Coliform bacteria may cause severe outbreaks of acute clinical mastitis during periods of hot, humid weather; extensive periods of heavy precipitation; or periods of stress, such as when cows are moved to new facilities.

Research supports a theory that coliform infections increase in a herd when that herd's somatic cell count is less than 200,000 and *Strep. ag.* and *Staph. aureus* infections are present in less than 10 percent of the cows. High-producing, non-infected older cows in early lactation (first 90 days) are most susceptible to coliform invasion.

Non-agalactiae Streptococci *(Non-ag. Strep.)*

There are many forms of *non-ag.* (environmental) *Strep.* bacteria, but two of the most common forms are *Strep. uberis* and *Strep. dysgalactiae. Non-ag. Strep.* survives mainly on the cow's teat skin and belly skin and in the reproductive tract. Infections can also be associated with unsanitary dry lots and bedding areas. *Strep. uberis* and *Strep. dysgalactiae* are usually transferred from the environment to the teat between milkings, but some transfer from cow to cow can take place during milking.

These infections range from chronic non-clinical cases to very severe acute cases. *Strep. uberis* is responsible for most new infections in dry cows. Like coliform mastitis, *non-ag. Strep.* cases tend to increase as *Strep. ag.* and *Staph. aureus* infections decrease.

In addition to *Strep. uberis* and *Strep. dysgalactiae,* there are many other environmental *streptococci,* such as *Strep. bovis* and *Strep. faecalis,* that can cause mastitis.

Pseudomonads

Pseudomonads are widespread in the environment and are often found in contaminated water supplies. New infections can occur during or between milkings via transfer from contaminated sites in the environment to teat ends. Infections may range from non-clinical to acute.

Bovine Mycotic Organisms (Yeast)

Mycotic (yeast) organisms are commonly found throughout the cow's environment in soil, air, water, and even on the cow's teat and udder skin.

Sporadic cases of mycotic mastitis that occur within a herd are often attributed to environmental sources. Severe herd outbreaks, however, are often associated with treatment-related actions, such as when single-dose syringes or cannulas are reused to apply multiple numbers of intramammary medications, or when poor aseptic techniques are followed when treatments are given.

Mycotic mastitis infections are often non-clinical but may be clinical, ranging from acute severe cases to chronic cases, which may result in permanent damage to mammary tissue.

Because high concentrations of yeast organisms are infectious, it is possible for humans (i.e., milkers, veterinarians) to develop yeast infections from infected cattle. To prevent such infections, wash hands and equipment thoroughly and disinfect following contact with infected cows.

MASTITIS COSTS DAIRY FARMERS IN MORE WAYS THAN ONE

Lost Production

Most dairy farmers are aware of the obvious costs of mastitis to their herds: discarding abnormal milk, culling top producing cows, replacing infected cows before their peak production year, and doctoring a cow through a clinical infection.

What many farmers do not fully realize is that the major dollar loss resulting from mastitis is due to reduced milk production from non-clinical mastitis cases. Since the loss of milk is usually not obvious, the loss of income associated with decreased production usually goes unnoticed.

In Michigan, a decrease in milk production from non-clinically infected cows accounts for about 55 percent, or $100, of the $190 annual cost per cow attributed to mastitis. At current milk prices, that lost production adds up to approximately $40 million.

Clinical mastitis cases account for about 26 percent, or $50, of that $190 cost. The rest of the cost is attributed to premature culling of mastitis-infected cows. These costs are typical of an average herd in which approximately 30 to 35 percent of the cows are infected with mastitis (see Table 1).

Milk Quality

Mastitis changes milk composition. Damage to milk-secreting cells causes a decrease in lactose, casein, and fat production. Cheese yield from mastitic milk (somatic cell count = 1,000,000) is lowered 5 to 10 percent, and milk price, if established on component pricing, will also be reduced by mastitis. As tissue damage increases, blood components such as sodium, chloride and serum albumin enter the milk in amounts greater than normal. Table 2 compares composition of normal milk with that of infected milk.

HOW NON-CLINICAL MASTITIS CAN BE DETECTED/MONITORED

Non-clinical mastitis can be detected in several ways, either on the farm or in a microbiological laboratory. Somatic cell testing, culturing and other forms of tests applied to milk can assess secretory cell damage.

Somatic Cell Counts

Cells found in milk consist of epithelial cells and leucocytes (white cells) from the blood, and are called somatic cells. Normal milk from individual non-infected quarters usually contains up to 200,000 somatic cells.

Somatic cell levels increase when a cow is infected, as a cow ages (because of greater probability of infection), and when a lactation is long and production drops below 20 pounds per day. (Infection is the most common reason for somatic

TABLE 1: Estimated mastitis costs in an average dairy herd with 30 to 35 percent of cows infected.

Item	Estimated cost per cow per year
Non-clinical mastitis — 10 to 15 percent production loss per infected cow	$100
Clinical mastitis — Cost of drugs, discarded milk, labor and veterinarian service	50
Premature culling	40
Total loss to dairy farmer	$190

TABLE 2: Composition of milk from normal cows and infected cows.

Constituent	Percent	
	Normal milk	Mastitis-infected milk
Water	87.0	87.0
Lactose	4.90	3.95
Casein	2.90	2.25
Whey proteins	0.82	1.31
Fat	3.50	3.20

cell increase, however.) By monitoring each cow with a monthly somatic cell count, the dairy farmer will get a better overall picture of the entire herd and also pinpoint individual problem cows that are responsible for increasing the bulk tank cell count. Table 3 outlines the predicted prevalence of infected quarters and daily milk production losses based on increases in bulk tank somatic cell counts.

A bulk tank somatic cell count that rises to 400,000 cells/ml milk or higher is a good indicator that a rise in the infection level has occurred in the herd. Indeed, many farmers find it necessary to continuously monitor their herd's somatic cell counts, since the price per cwt (hundredweight) of milk that they are being paid will be reduced if the bulk tank somatic cell count exceeds certain levels.

The DHIA somatic cell count program, the Wisconsin Mastitis Test (WMT), and the California Mastitis Test (CMT) are all commonly used to estimate somatic cell counts in the milk. These somatic cell count programs are discussed in detail in another Extension bulletin.

Culturing

Culturing involves collecting milk samples under sterile conditions and submitting them to a qualified microbiological laboratory (such as the state animal health diagnostic lab), which then determines the type of organism responsible for the infection and increase in somatic cell count in the cow.

To help diagnose a mastitis problem within a herd, all cows, or a minimum of 10 to 20 lactating cows in the herd, should be cultured. Any individual cows with cell counts between 600,000 and 1,000,000 also should be cultured. A local veterinarian or milk cooperative fieldperson can explain the proper procedures for taking a culture and help you interpret the results.

Other Tests

Other tests that can be used to analyze milk samples for prevalence and severity of mastitis include NAGase and milk conductivity. These testing methods can be used as indirect measures of secretory cell damage.

After the level of infection in a herd is known and the bacteria causing the problem are identified, management practices can be altered to control mastitis in a herd. Changes may be as simple as improving farm sanitation, correcting milking routines, using the appropriate antibiotic treatment for lactating and dry cows, or culling problem cows to remove the source of infection. A complete mastitis control program should be implemented to reduce mastitis to acceptable levels.

SUMMARY

Mastitis can be a widespread problem among dairy farms, but the causes can usually be identified, and the dairy farmer can make management changes and implement control programs to help alleviate problems and keep them from recurring.

More information on the specific bacteria that cause mastitis and how to control them can be found in other Extension bulletins. Contact your county Cooperative Extension Service office for details on the bulletins, or your local veterinarian for help in controlling mastitis.

Mastitis Control Program Series edited by Kristen Penner.

TABLE 3: Predicted prevalence of infection and production loss based on bulk tank somatic cell counts.

Bulk tank SCC	Percentage of infected quarters	Daily milk (lb/cow)	Percentage loss
200,000	6	50.8	
500,000	16	47.5	6.5
1,000,000	32	41.8	17.7
1,500,000	48	36.2	28.7

SOURCE: Journal Series Paper 6268, The Pennsylvania State University Agriculture Experiment Station

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