Sources of Different Mastitis Organisms and Their Control

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Introduction

Mastitis is unlike other diseases of dairy cattle in that it is caused by a multitude of different microorganisms, and the key to the control of all forms of mastitis is prevention. The disease is caused by more than 140 different microorganisms. The goal of every dairy farmer should be to minimize the number of organisms permitted to come into contact with the teats. Fortunately, the vast majority of mastitis cases is caused by a relatively small number of microorganisms that can be grouped into three categories: (1) contagious; (2) environmental; and (3) other. A high somatic cell count (SCC) combined with a low level of clinical mastitis usually indicates a problem with contagious mastitis, while a low SCC and a high incidence of clinical mastitis usually indicates a problem with environmental mastitis. Each group of mastitis organisms will be discussed separately because the sources and methods of control are somewhat different.

Contagious Organisms

The organisms of importance in this group include Streptococcus agalactiae, Staphylococcus aureus, Corynebacterium bovis, and Mycoplasma species. Spread of these pathogens from an infected cow to an uninfected cow occurs almost exclusively during the milking process. Purchased herd replacements are sometimes the source of contagious organisms not previously seen in a dairy herd. All replacement animals should be sampled and cultured to detect the presence of any contagious infections before the animals are introduced to the herd.

Some general recommendations for controlling contagious mastitis organisms include: (1) milking teats that are clean and dry; (2) using good milking machines correctly; (3) dipping (not spraying) teats after milking (teat spraying is almost never as effective as teat dipping); (4) treating quarters infected with Streptococcus agalactiae during lactation; (5) treating every quarter at drying off with a specially formulated antibiotic; (6) segregate known infected cows if possible, and (7) prevent heifers from becoming infected by practicing excellent fly control and possibly treating heifers at or near parturition. Some animals with chronic infections may need to be culled to prevent them from being a reservoir of infection for other animals in the herd.

Streptococcus agalactiae

The only reservoir of importance for Streptococcus agalactiae is infected mammary glands, thus the spread of this organism occurs during milking. A comprehensive mastitis control program should be followed that includes: (1) excellent milking hygiene; (2) use of good milking equipment in the correct manner; (3) dipping (not spraying) teats after milking with an effective teat dip; (4) treatment of every quarter at drying off; and (5) avoiding the purchase of infected animals.

If a herd exhibits a high prevalence of this organism, and the bulk tank somatic cell count (SCC) and bacteria count are also elevated, then culturing of milk samples from the entire herd is indicated. All lactating cows should be sampled and cultured, and all infected quarters treated one or two times with penicillin or another suitable antibiotic. In most herds, about 90% of the quarters will be cured of infection. Follow-up culture and re-treatment for a longer period of time must be performed if eradication is to be achieved within a short period of time. Animals that were not cured by the two treatment regimens should be culled immediately because they will infect other animals in the herd. Prevention of Streptococcus agalactiae mastitis is best accomplished by maintaining a closed herd. All replacement animals, including purchased heifers, must be sampled and cultured.
before being added to the milking herd. Samples of bulk tank milk should be cultured on a regular basis to monitor for reinfection of the herd.

**Staphylococcus aureus**

The spread of *Staphylococcus aureus* occurs primarily at milking time, though a few infections may originate from the environment via flies. This organism is impossible to control by antibiotic therapy alone. Thus, control depends on preventing spread from infected quarters to uninfected quarters by following the procedures outlined under “contagious organisms” above. Treatment during lactation is often of little value, particularly in instances of chronic infections characterized by a high SCC.

The spread of *Staphylococcus aureus* within a dairy herd can be reduced by milking: (1) first-lactation animals first; (2) uninfected cows second; and (3) known infected cows last. The use of vaccines against this organism has been somewhat effective, but their use should be considered as an adjunct to control programs discussed above, rather than as a replacement for those programs.

**Corynebacterium bovis**

This organism rarely causes clinical mastitis and causes only a modest increase in the SCC, usually in the range of 200,000 to 300,000. Most heavily infected herds have poor milking hygiene. New infections usually are easily prevented by the consistent application of an effective teat dip program (not teat spraying). In addition, this organism is highly susceptible to dry cow therapy. The bottom line with this organism is that herds with a high level of infection usually have not maintained adequate teat dipping and dry cow treatment programs, which should be practiced conscientiously to avoid infection with this and other mastitis pathogens.

**Mycoplasma species**

*Mycoplasma* organisms are extremely contagious and may spread through a herd with devastating financial consequences. The most common species is *Mycoplasma bovis*, though other species may also cause infections. The organisms usually enter an expanding herd via purchased replacements. It is not uncommon for herds that have experienced an outbreak of *Mycoplasma* mastitis to be free of the organism in lactating animals for 2 years and again have a problem when calves born during the previous outbreak freshen and enter the lactating herd.

The disease should be suspected when: (1) more than one quarter (often all four quarters) have clinical mastitis; (2) affected quarters do not respond to treatment; (3) milk yield decreases quickly and significantly; and (4) abnormal secretions are observed such as watery milk with a few clots or colostrum-like secretions with sandy or flaky sediment. Herds that routinely cull such animals and practice excellent milking hygiene with effective teat dipping can avoid, or at least minimize, spread of the infections.

Only commercially prepared mastitis treatment tubes should be used when infusing drugs into udders because home-prepared or veterinarian-prepared bottle mixes of antibiotics are known to become contaminated with *Mycoplasma*. In addition, excellent pretreatment hygiene must be used. Specific management procedures include: (1) backflushing of teat cup liners between cows to reduce spread of the organisms; and (2) segregation of cows with clinical mastitis. Extreme care must be taken not to combine cows with clinical mastitis with recently freshened cows. Moreover, regular maintenance of the milking equipment may also help minimize spread of the organisms.

In herds experiencing an outbreak with *Mycoplasma* mastitis, cows in all infected milking strings must be cultured and affected animals should be immediately segregated or culled from the
herd. Treatment with antibiotics is of no value. Culturing of bulk tank milk on a monthly basis, and culturing of all clinical cases of mastitis, should be initiated to monitor the herd infection status. All fresh heifers and cows should be sampled and cultured before being added to the milking herd. A small percentage of infected animals will clear the infection spontaneously, but the keeping of infected animals with this hope in mind is a very dangerous practice and may be financially devastating, especially if the infected animals are not isolated in a milking string that is milked separately using excellent hygiene.

**Environmental Organisms**

The widespread belief that environmental mastitis has become more prevalent in recent years is not correct, though this form of the disease does now comprise a larger percentage of the total mastitis problem than in previous years. The reason for these conclusions is that mastitis caused by contagious organisms has decreased due to application of effective control programs. Interestingly, the incidence of mastitis caused by environmental organisms has actually decreased in the majority of dairy herds, but these organisms are now the major cause of mastitis in most well-managed dairy herds. Some of the environmental organisms are known to exhibit contagious characteristics because some infections are obviously spread during the milking process as evidenced by the fact that predipping aids in controlling spread of the disease.

The level of infection is usually in the range of 3 to 10% of quarters and 12 to 16% of cows, with the most common organism being *Streptococcus uberis*. Environmental organisms can be grouped into two broad categories including: (1) streptococci (and enterococci) other than *Streptococcus agalactiae*; and (2) Gram-negative bacteria, primarily coliforms such as *Escherichia coli*, *Klebsiella* species, *Enterobacter* species, *Citrobacter* species, and *Serratia* species. Traditional mastitis control methods effective against contagious mastitis organisms are of limited value against organisms of environmental origin because they are widespread in the environment of the cow.

**Characteristics of Environmental Infections**

Characteristics of herds experiencing problems with environmental mastitis include the following: (1) contagious mastitis has been reduced to a minimum level; (2) herd SCC levels are low, often below 200,000; and (3) the level of clinical mastitis in unacceptably high. Management often appears to be very good, but subtle deficiencies can be identified, especially in hygiene, upon close evaluation of the environment and milking procedures. Compared to contagious organisms, the environmental organisms are: (1) of shorter duration; (2) more likely to cause clinical mastitis; and (3) less likely to cause a high SCC in herd milk because most infections become clinical and the abnormal milk is withheld from the milk supply.

Infection characteristics of environmental streptococci include: (1) 40% will persist for less than 8 days; (2) 60 to 70% will persist for less than 30 days; (3) 18% will persist for more than 100 days; (4) 40 to 50% will become clinical; and (5) 50% will develop during the dry period, especially during the 2 weeks before parturition. Infection characteristics of coliforms include: (1) 57% will persist for less than 10 days; (2) 70% will persist for less than 30 days; (3) 2% will persist for more than 100 days, with most being *Klebsiella* species; (4) 90% will become clinical; and (5) 10% will cause peracute clinical mastitis.

**Reservoirs of Infection**

The most common sources of environmental organisms include: (1) bedding materials; (2) manure; (3) dirt and mud; (4) pools of standing water; and (5) feeds. The most important single
source is bedding materials because teats are in frequent and prolonged contact with bedding. Thus, prevention of teat contamination is critically important and the practice of maintaining bedding materials in a dry condition will aid in minimizing populations of these organisms. Experience has also shown that areas around shade areas can harbor populations of environmental organisms comparable to those found in the bedding of housed animals. Other sources of these organisms include: (1) contaminated rags and sponges used for washing udders; (2) wet and manure-covered alleyways; (3) multiple dose containers of antibiotics; (4) areas around feed bunks; and (5) contaminated treatment syringes, cannulas, and needles.

Control Methods

The primary emphasis must be placed on decreasing moisture in the environment and decreasing exposure of teats to potential environmental pathogens during both lactating and dry periods. Exposure of teats to the organisms can be reduced by: (1) maintaining cows on clean pastures (shade areas must also be clean); (2) using inorganic bedding such as sand in free stalls that are well maintained to minimize moisture content; (3) maintaining dry cows and heifers in the cleanest possible environment on the dairy farm, especially during the 2 weeks prior to calving; and (4) using excellent premilking hygiene, which includes predipping and the application of milking units to teats that are clean and dry. Other important control methods include: (1) treatment of every quarter of every cow at drying off; (2) feeding all animals diets that contain adequate amounts of vitamins A and E and the trace mineral selenium; (3) vaccinating cows with a mutant strain of *Escherichia coli* J5 vaccine for the control of Gram-negative infections; (4) using properly functioning milking equipment in the correct manner; and (5) reducing stress on animals to the practical minimum.

Other Organisms

The vast majority of organisms in this group rarely cause clinical mastitis and are not of serious economic importance to the dairy industry, though they do infrequently cause serious problems in dairy herds that do not practice good management. The most important “other organisms” will be discussed briefly, including coagulase-negative staphylococci, *Serratia* species, *Pseudomonas aeruginosa*, *Nocardia asteroides*, *Prototheca* species, *Candida* species (yeasts), and *Arcanobacterium pyogenes*, which was know previously as *Actinomyces pyogenes*, and *Corynebacterium pyogenes*.

Coagulase-Negative Staphylococci

Coagulase-negative staphylococci (CNS) are isolated more frequently from milk samples than any other organism. They are often referred to as “skin flora opportunists” because they can be isolated from: (1) teat skin; (2) teat canals; (3) vaginas; (4) hair coats; and (5) nasal passages. They are neither contagious nor environmental and they rarely cause clinical mastitis. Even when they do cause clinical cases the cases are usually very mild.

The CNS were largely overlooked for many years but there has been increased interest in them in recent years because of: (1) the continuing international tendency to reduce SCC enforcement standards; (2) widespread emphasis on premiums paid for high quality milk; and (3) the realization that they do cause a reduction in milk production of up to 8.7% compared to uninfected quarters. The average SCC for CNS-infected quarters is significantly higher than for uninfected quarters, usually in the range of 200,000 to 300,000, though with some quarters may have counts as high as 700,000.

Traditional mastitis control methods that include teat dipping and dry cow treatment are effective in controlling the CNS, but the degree of control is less than for contagious organisms. These organisms account for 60% of all infections at first parturition, but the spontaneous cure rate
in early lactation is often as high as 40%. The infections also occur during the dry period but many disappear during the first few weeks after calving.

**Serratia Species**

*Serratia* organisms are of environmental origin and cause mastitis in both lactating and dry cows. They are frequently isolated from soil, water, feed, and grass. Thus, the organisms come into contact with teats from environmental sources. The infections do not respond well to antibiotic therapy. *Serratia marcescens* has been isolated from certain teat dips and teat dip containers, especially chlorohexidine dips.

Control of these organisms is best achieved by keeping cows in as sanitary an environment as possible to minimize exposure of teats. The practice of predipping with an effective teat dip, followed by careful drying of the teats before attaching milking units, may also aid in reducing the number of contaminating organisms on teat skin. Use of the J5 mutant Gram-negative core antigen vaccine will also aid in reducing the incidence and severity of clinical cases.

**Pseudomonas aeruginosa**

When this organism is a problem, all water sources should be tested immediately. The organism has been isolated from hot water heaters that provide warm water for washing teats and udders. In addition, the organism has been isolated from: (1) wet bedding; (2) improperly cleaned milking equipment; (3) wet areas in the environment; (4) soil; (5) feces; (6) contaminated antibiotic preparations and syringes; and (7) a few non-iodophor teat dips. The cure rate from antibiotic treatment is disappointing. Elimination of infections involves: (1) culling of affected cows; or (2) destruction of mammary gland tissues by having the herd veterinarian inject an appropriate chemical.

Prevention is based on: (1) preventing teat end contamination by maintaining cows in a clean and sanitary environment; (2) checking water sources for contamination; (3) using an effective predip, followed by careful drying of teats before milking; (4) sanitizing teat dippers between milkings; (5) using excellent hygiene when administering antibiotic treatments; and (6) using the J5 mutant Gram-negative core antigen vaccine.

**Nocardia asteroides**

This organism causes very refractory infections that are characterized by palpable nodules and extensive scar tissue formation. Antibiotics are of no value and almost all infections become chronic with intermittent flare-ups of mild clinical mastitis. The organisms are widespread in the environment of cattle including: (1) soil; (2) water; (3) air; (4) bird feces; (5) grass; and (6) skin of teats and udders. Other sources include: (1) contaminated homemade antibiotic products; (2) contaminated syringes, cannulas, and needles; and (3) inadequate teat sanitation prior to administering antibiotic treatments. Spread may also occur during milking by contaminated water and unsanitary milking units.

Control involves preventing spread of the organisms from the sources mentioned above. Experience of the author with nocardial infections suggests the vast majority are associated with faulty treatment procedures. Affected cows must be culled or the affected quarter destroyed by having the herd veterinarian infuse an appropriate chemical to destroy the milk producing tissues.

**Prototheca Species**

These are achlorophyllic algae. They are generally classified as environmental pathogens, but they can be spread from cow to cow at milking time. The most common sources include: (1) water, including ponds, streams, and other water-contaminated sites; (2) soil; (3) feces; (4) barns
and holding areas; (5) purchased animals; and (6) contaminated bedding. They may also be spread during the process of administering antibiotic treatments due to failure to adequately sanitize teat ends.

Affected cows may have either clinical or subclinical mastitis. Systemic signs rarely develop, but infected quarters may be swollen and hard. Milk yield will be depressed and the bacteria count of herd milk will be elevated. Infected cows should be milked last or with a separate milking unit until removed from the herd. Antibiotic treatment is of no value.

Candida Species (Yeasts)

These organisms are associated with: (1) feed products such as brewers grains; (2) plant materials; (3) soil; (4) water sources; (5) contaminated antibiotic preparations, especially multiple-dose homemade remedies; (6) contaminated treatment devices such as syringes or cannulas; (7) exudates from infected animals; and (8) decaying organic matter.

The majority of clinical cases will regress spontaneously and antibiotics should not be used to treat such cases because they will be of no value and may actually make the clinical symptoms worse. Affected animals should be separated from other animals and extreme care should be taken during milking to avoid spreading the organisms.

Arcanobacterium pyogenes

This organism was previously known as Actinomyces pyogenes and as Corynebacterium pyogenes. This form of mastitis is primarily a disease of dry cows and heifers. The primary method of transmission is via blood-sucking flies, though the organisms may also be spread via contact of the teats with other contaminated materials such as in dry cow and maternity areas. The disease is characterized by acute, purulent secretion from the affected quarter that has a very pronounced foul smell. Affected quarters usually cease to function and should be dried up or the milk secreting tissues destroyed by the herd veterinarian by injecting an appropriate chemical. The frequent stripping of affected quarters may aid in minimizing the possibility of abscess formation to the exterior of the affected udder.

Control of the disease is best accomplished by: (1) minimizing the fly population, especially on non-lactating animals during the summer months; (2) maintaining dry cows and heifers in a clean and sanitary environment; and (3) administering dry cow therapy to every quarter at drying off. Although drug resistance tests in the laboratory show the organisms to be sensitive to many antibiotics, drug therapy is useless.

Summary

Great progress can be made in controlling most forms of mastitis by following a few very practical procedures such as: (1) maintaining cows in an environment that is as clean and dry as possible; (2) milking teats that are clean and dry; (3) minimizing stress thus enhancing the ability of animals to maintain a healthy immune system and resist infections; and (4) practice excellent herd management, which may ultimately be the difference between success and failure in today's competitive dairy industry with decreasing profit margins. Remember also that for every mastitis problem, there is a solution. The preferred approach, however, is to prevent such problems rather than attempting to solve them after they develop.

References


