AABP FACT SHEET

STAPHYLOCOCCUS AUREUS AND MASTITIS

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Staphylococcus aureus is a gram positive coccus which is part of the normal skin flora. When this organism gains access to the mammary gland it can cause mastitis. The mastitis can be either clinical or subclinical. Generally, there are few systemic signs of the disease unless it has progressed to gangrenous mastitis, which is uncommon in today's dairy operations. Most commonly, _S. aureus_ infections are chronic. Cattle that are infected may initially show intermittent clinical signs such as flakes and/or clots in the milk. Quarters infected with the agent can show extremely high somatic cell counts yet exhibit intermittent shedding of the organism. At the herd level, _S. aureus_ mastitis is a potentially devastating disease that can be a severe economic liability to the dairy. If enough animals are infected, the dairy could be degraded due to an elevated somatic cell count (SCC).

SOURCES

Staphylococcus aureus can live on the skin of the mammary gland and can gain entrance to the mammary gland during the milking process. This is especially the case if the milking equipment is not functioning properly. However, infection can occur in spite of the best milking equipment and maintenance programs. Infected cattle can act as fomites, with transmission from these infected cattle to uninfected cattle occurring during the milking process, either via the machine, the milker's hands or contaminated towels. The organism can also be introduced onto the dairy by way of cattle that have been purchased and placed into the milking string. In either scenario, the organism can become endemic within the herd if not recognized in a timely manner.

DIAGNOSIS

Staphylococcus aureus is a gram positive coccus that often exists in clusters. It is facultatively anaerobic and can be easily cultured on most of the standard enrichment media commercially available, the most commonly utilized being blood agar. When grown on blood agar, it forms round yellow or golden color colonies with surrounding zones of hemolysis. *S. aureus* is catalase positive, allowing for differentiation from enterococci and streptococci, and coagulase positive, allowing for differentiation from other staphylococci. Recently, a PCR test has been introduced to detect *S. aureus* in bovine mastitis milk samples[7].

EPIDEMIOLOGY

S. aureus possesses a large capsule that can aid in protecting the microbe from the host's defense system. It has been demonstrated that it can survive intact within neutrophils and mammary epithelial cells[1]. It also has the ability to wall itself off into micro-abscesses that further protects from the immune system and also from the common antimicrobials that would be used to combat this infection. Recent research has also demonstrated that some strains of *S. aureus* can form biofilm in vitro[1,2,3]. Biofilm formation would also contribute to the survivability of the organism within the host, as the polysaccharide matrix of the biofilm hinders the penetration of antibiotics and serves as a barrier to the immune system.

Healthy skin can support *S. aureus* bacteria for short periods of time, but colonization of the tissue is hard to establish. If the skin has been damaged, then colonization occurs more easily. Colonization in the region of the teat sphincter would allow the bacteria to elude the first barrier of the mammary immune system and gain access to the teat cistern, and then the rest of the gland. Colonization of the epithelial lining of the mammary ducts initiates the new intra-mammary infection. These colonies can then progress to form microabscesses or biofilm or both, establishing the infection in the gland, hindering the innate immune system and leading to the chronic form of the disease.

As this infection persists, immune system cells are mobilized to the area. These cells, attempting to fight off the infection, proceed to damage and destroy the epithelial cells. Studies that have looked at the effect of intramammary infection with *S. aureus* during epithelial cell development around parturition have shown that infected cows have significantly less alveolar lumen size and fewer active epithelial cells as compared to uninfected controls[4]. Infected epithelial cells have significantly less cell area occupied by rough endoplasmic reticulum and more of the cell area composed of unoccupied cytoplasm[4]. In addition, the basal secretory cells are disrupted from the underlying plasma membrane by macrophages and lymphocytes and more macrophages and neutrophils are observed within the alveolar lumen as compared to uninfected tissue[4]. Through the normal process of inflammation, infected areas are walled off, forming microabscesses and establishing the infection as chronic. Occasionally, bacteria escape the infected area and move into other areas of the gland or are shed in milk to allow infections in other animals.

Because of this abscessation, or biofilm formation, or both, intermittent shedding of the organism is a hallmark of *S. aureus* mastitis and the biggest hindrance to a reliable control program. Detecting the infected animal(s) within the herd may require multiple samplings. Because of the possibility of intermittent shedding and the generally low concentrations of

bacteria shed, bulk tank samplings from infected herds can vary from being *S. aureus* culture-negative to containing hundreds of colony forming units per milliliter. Therefore, when establishing an eradication and/or control program, one should always consider sequential screenings to establish the level of infection within the herd and multiple herd cultures to determine the infected individuals. Individual cow somatic cell counts (SCC) can be utilized to determine the likely infected individual; however, one study has shown that 32% of cows infected with *S. aureus* had a SCC <200,000[5].

CONTROL

Successful control of *S. aureus* infections is predicated on proper pre-milking and post milking hygiene, proper milking technique, sound biosecurity practices, and culling and segregation to limit spread of new infections. In some instances, the most important issue to address is the economic impact on the dairy when faced with high infection rates. Keeping the dairy afloat financially when a considerable portion of the herd is infected can be a daunting task. Dairy management should be informed that eradication could be a long term process and working with their veterinarian to agree upon a realistic time frame is a good first step. Within this expected discussion, the veterinarian and dairy management team should establish goals for monitoring progress. The plan needs to include an aggressive culturing protocol in which several whole herd cultures maybe necessary to find all of the infected cows due to intermittent shedding of the bacteria. In addition, culturing all incoming first calf heifers should be included as research has shown that a significant number of these animals can be infected[6]. Cows that are still economically viable should be segregated from culture negative animals in order to reduce new IMM infections. Culture positive animals should be treated no differently than any other animal on the farm with the exception of the segregation process. These culture positive cows should be milked last after the culture negative cows. A method for continued monitoring should be established. This could be composite string samples on a routine basis, blanket culturing of all cows when they go dry and/or when they come fresh, and culturing all cows above a threshold somatic cell count level or cows that manifest with clinical mastitis are all examples of valid monitoring programs. Another aspect of a solid control and eradication program that should be considered is the dry cow therapy program. All animals should be treated with an approved intramammary preparation developed specifically for the dry period. In addition to dry cow treatment, other treatments that are instituted to treat *S. aureus* infections need to be of sufficient length to allow for the bacteria that are surviving within neutrophils to be released and exposed to treatment. Because of the pathogenicity factors mentioned previously, one should adopt the attitude that these treatments would not necessarily lead to clearance of the organism from the animal. One very important rule to remember is "ONCE A *STAPH* COW, ALWAYS A *STAPH* COW!" There has long been a commercial vaccine available for *S. aureus*; however, research to document the vaccine's effectiveness is limited.

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