Vaccination against Staphylococcus aureus Mastitis in Dairy Cattle

Staphylococcus aureus Mastitis

Staphylococcus aureus is a major mastitis pathogen because it can be highly contagious and have a significant impact on farm income. S. aureus primarily causes subclinical intramammary infections (IMI) that often become chronic. It also has a negative economic impact from increased milk somatic cell counts (SCC) and decreased milk production. However, there are regional and herd differences, and in some instances, S. aureus may cause a high rate of clinical mastitis.

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As early as the 1960s, numerous researchers established the standards for contagious mastitis control on dairy farms (Davidson, 1961; Wilson and Davidson, 1961; Neave et al., 1966; Dodd et al., 1969; Neave et al., 1969). From this work came the five-point mastitis control program. Implementation of the five-point plan, which was later developed into the National Mastitis Council 10-point mastitis control plan, successfully reduced the prevalence of contagious mastitis on many farms. However, S. aureus can still plague individual farms and significantly impact milk quality (Smith et al., 1998).

Vaccination against S. aureus mastitis has been studied for many years, but none of the vaccines studied to date have consistently prevented S. aureus infections. The goal of an S. aureus mastitis vaccine should be to prevent new IMI or facilitate clearance of new IMI as soon as possible after infection, thus minimizing cow-to-cow transmission.

Vaccines

Currently, there are two commercially available S. aureus mastitis bacterins (vaccines) labeled for bovine mastitis.
Lysigin® (Boehringer Ingelheim Vetmedica Inc.) is available in the United States, and Startvac® (Hipra) is available in Europe and Canada.

**Lysigin**

**Lysigin: Early Studies**

Lysigin is a multivalent whole cell lysed *S. aureus* bacterin (a mixture of numerous strains of *S. aureus* bacteria that have been disintegrated into smaller parts) that contains common varieties of *S. aureus* that cause mastitis in the United States. Initial studies with Lysigin in experimental infections seemed to help lower clinical mastitis effects, SCC, and the occurrence of infections that became chronic (Williams et al., 1966; 1975). Nickerson and co-workers (1999) vaccinated heifers with commercially available Lysigin at 6 months of age followed by a booster 2 weeks later and subsequent booster vaccinations every 6 months until calving. Vaccinates had a 45% reduction in both new *S. aureus* IMI during pregnancy and new *S. aureus* IMI at calving relative to controls. In addition, vaccines had a 30% reduction in new coagulase-negative staphylococci (CNS) IMI which became chronic and a 31% reduction in new CNS IMI at calving relative to controls, providing evidence that Lysigin may be of use in reducing staphylococcal mastitis in heifers vaccinated early in life with frequent follow-up vaccinations.

**Lysigin: Recent Studies**

More recently, the efficacy of Lysigin was studied in experimental *S. aureus* infections in heifers (Middleton et al., 2006). All cattle became infected with *S. aureus* after challenge. Cattle vaccinated with Lysigin had clinical mastitis symptoms that were milder and cleared faster than unvaccinated animals. However, the vaccinated animals did not have lower SCC or greater milk yields than unvaccinated animals. Furthermore, anti-*S. aureus* antibody levels in milk were not different from control animals, suggesting that vaccination provided minimal immune protection (Luby et al., 2007). In a follow-up field study in milking cows in a herd with 5% of cows infected with *S. aureus* and 40% of the cows infected with CNS, the vaccine did not reduce the new staphylococcal intramammary infection rate, and the vaccine failed to provide sufficient antibodies in milk to help leukocytes (white blood cells) eliminate staphylococcal bacteria from the mammary gland (Middleton et al., 2009).

**Lysigin: As an Adjunct to Antimicrobial Therapy**

Lysigin has also been studied as an adjunct to antimicrobial therapy. In one study, cattle vaccinated with Lysigin and treated with extended intramammary pirlimycin had a higher cure rate than non-treated controls (Smith et al., 2006). However, to determine whether the ability to eliminate *S. aureus* IMI was the effect of the antimicrobial therapy or vaccine, two other studies evaluated Lysigin in conjunction with extended pirlimycin therapy versus extended pirlimycin therapy alone and showed no differences in cure rates between groups (Luby and Middleton, 2005; Middleton et al., 2007). Thus, cure rates of *S. aureus* IMI following antimicrobial therapy do not benefit from vaccination with Lysigin.

**Startvac**

Startvac is a multivalent vaccine marketed by Hipra in Europe and Canada (not the United States) that contains inactivated *Escherichia coli* (J5) and inactivated *S. aureus* (CP8) SP140 strain expressing slime associated antigenic complex (SAAC). The label indication is to reduce the incidence of subclinical mastitis and decrease the clinical severity of mastitis caused by *S. aureus*, coliforms, and coagulase-negative staphylococci. Similar to other *S. aureus* bacterins, Startvac has been shown to stimulate antibody production in blood and decrease inflammation in the mammary gland following experimental challenge with an inactivated strain of *S. aureus* (Piepers et al., 2012). While vaccination does not completely prevent intramammary infection, results of a recent field trial demonstrate a decreased duration of IMI and decreased transmissibility of infection (Schukken et al., 2014).

**Summary**

Vaccination is not a substitute for excellent milking time hygiene and implementation of the National Mastitis Council 10-point mastitis control program. The vast majority of herds have been able to control contagious mastitis from consistent application of fundamental prevention practices such as milking hygiene, post-milking teat dipping, and dry cow therapy.

Managing *S. aureus* mastitis depends on:

- Following good mastitis prevention protocols
The level of infection in a herd

- The type of strain(s) of *S. aureus* in the herd:
  - how likely the bacteria can spread from one cow to another
  - whether the strain is able to create chronic infections, and
  - whether the strain is virulent enough to frequently cause clinical mastitis

Use of herd records to determine new infection rates (from DHIA SCC) and response to therapy will be valuable tools in making management decisions. If the *S. aureus* infections in a herd usually become chronic and don’t respond to treatment, culling or drying off quarters may be the best way to maintain milk quality in the bulk tank. Alternatively, sporadic cases of *S. aureus* caused by isolates that have no consistent pattern of infection may not have herd-wide implications, and management strategies can be applied at the level of the individually infected cow. Vaccination against *S. aureus* mastitis often does not prevent IMI but may help reduce the cow-to-cow transmission within a herd, especially if a high number of cows are infected. Repeated vaccination of heifers prior to calving may lower the incidence of staphylococcal IMI, although the impact of this approach will vary greatly depending on the infection level within a herd and must be weighed in terms of labor, risk of antimicrobial residues, and other means of control, including in some areas, control of biting flies.

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**References**


