Improved BVD Vaccine

by Alberta Beef Producers

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Project Title:

Novel vaccination strategies for induction of long-term immune memory and protection to bovine viral diarrhea virus

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Published:

- Electroporation enhances immune responses and protection induced by a bovine viral diarrhea virus DNA vaccine in newborn calves with maternal antibodies
- Electroporation for DNA immunization: clinical application
- Electroporation-based DNA transfer enhances gene expression and immune responses to DNA vaccines in cattle

Background:

Bovine viral diarrhea virus is a problem for both cow-calf and feedlot producers. There are two types of BVD infections that are caused by different strains of the BVD virus. Type 1 BVD results in a brief, mild disease that causes diarrhea, fever and increased respiration rate. At the same time, it weakens the immune system so that calves are more likely to develop secondary bacterial pneumonia, leading to Bovine Respiratory Disease (BRD) in the feedlot. Type 2 BVD causes a more severe form of the disease and can be fatal. Pregnant cows that are infected can give birth to persistently infected calves. At the cow-calf level, BVDV can impair fertility, cause abortion, or produce calves with congenital defects or persistent BVD infections. Persistently infected calves do not get sick, but can pass the disease to others.

Current BVD vaccines exist in either a modified live or killed form. While modified live vaccines are generally effective, they are not safe for use in and around pregnant cows. Killed vaccines are safe for all classes of animals, but have lower effectiveness in terms of inducing cell-mediated and long-term immunity. In addition, vaccines for Type 1 BVD do not necessarily protect against Type 2 BVD. A different method of vaccination that seems promising involves injecting the DNA from the bacteria or virus that causes the disease to stimulate immunity. DNA vaccination has been shown to produce effective immune responses, do not inadvertently cause disease (like modified live vaccines), and are cheaper to produce.

Objectives:

To develop a DNA vaccine delivery method that will lead to stronger, longer lasting immune responses to bovine viral diarrhea virus (BVDV).

What They Did:

The TriGrid™ Delivery System is a relatively new method of delivering DNA vaccinations using a process called electroporation. Electroporation uses electrical impulses to create pores in cells that make DNA insertion into cells easier. This system uses multiple active electrodes arranged around a central injection needle. The TriGrid™ system was compared with conventional intramuscular (IM) DNA vaccine injections in terms of ability to initiate a stronger, longer lasting immune response to BVD. Newborn calves with maternal antibodies were also vaccinated using both delivery methods to determine whether either method provided BVD protection even in the presence of maternal antibodies. The final trial compared a two-dose vaccination strategy (weaning and feedlot entry) with three vaccinations, as well as the duration of immunity induced by the TriGrid™ Delivery System.

What They Learned:

Calves generally reacted well to injections using the TriGrid™ system, without having to be anesthetized or sedated, and no tissue damage was generated. This indicates that this method could be practical for delivering DNA injections. The researchers found that immune system response when the DNA vaccine was delivered using the electroporation method as compared to conventional IM injections. The same type of delivery protected newborn calves from clinical signs of disease, while conventional IM delivery of the DNA vaccine only partially prevented morbidity and mortality from BVD. Most vaccines have very low success rates on newborn calves because the passive immunity acquired from the dam through colostrum interferes with stimulating the calf's own active immune system. This trial demonstrates that a DNA vaccine for BVD could be administered to newborn calves via electroporation and provide excellent protection. Finally the researchers discovered that two immunizations using this method (one at weaning and one upon entry to the feedlot) provided the same amount of protection from BVD as three immunizations, and that this level of immunity persisted for at least four months.

What It Means:

There are currently no DNA vaccines approved for use in cattle, but there are DNA vaccines approved for use in horses, salmon, dogs, and many DNA vaccines undergoing human clinical trials. The many benefits of DNA vaccination, such as low cost of production and inability to accidentally cause disease, are making it an attractive option to combat disease. As one of the problems with DNA vaccines has been delivery, this research proved that electroporation is a viable and effective method of delivery for a DNA vaccine against BVD for calves of all ages. As economic losses from BVD alone are estimated to be about $2 billion annually in North America, this technology could have a beneficial impact on the competitiveness of both Albertan and Canadian cattle when it becomes available to industry.

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