Vaccination strategies for beef cattle

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Abstract

Vaccines are used at various times during the beef production system with the goal of safe immunization and prevention of diseases caused by viral and bacterial pathogens. Immunization involves a complicated but coordinated network of innate and adaptive immune responses to antigen(s) over a period of days to weeks, ideally in an immunocompetent host in a state of homeostasis. However, bovine respiratory disease (BRD) involves stress and immune dysfunction in its pathogenesis, it usually occurs soon after arrival, and vaccination with modified-live virus (MLV) during stress and natural BRD challenge may be harmful in some animals. Complicated factors to consider regarding vaccination of beef cattle include timing, antigen inclusion, route of administration, and frequency of vaccination. Calves that are marketed to feedlots without previous vaccination are typically considered high-risk because they are likely to also lack weaning, deworming, and castration prior to marketing. Furthermore, high-risk cattle experience stress-induced immune dysfunction because multiple stressors occur simultaneously. Veterinary practitioners should consider new research on vaccination during physiological stress and natural pathogen exposure to better guide recommendations and expectations of their clients.

Key words: bovine respiratory disease, stress, vaccination

Introduction

Bovine respiratory disease (BRD) is the most prevalent and costly disease affecting beef cattle in North America,[5] and numerous vaccines containing respiratory-associated antigens are commercially available in the US. Vaccine formulations include killed (inactivated) or modified-live (live-attenuated or avirulent live) versions for virus and bacteria involved in BRD in many different combinations (i.e., pentavalent, trivalent, monovalent, and viral/bacterial). Parenteral and intranasal vaccines are also available. Although the availability of commercial vaccine products is abundant, field research evaluating their safe and effective use in the many scenarios a veterinary practitioner may encounter is scarce. The current research symposia outline respiratory vaccine considerations with focus on timing of MLV respiratory vaccine use in beef cattle.

Pre-weaning Vaccination

The first opportunity to vaccinate beef calves is near birth, but immunological and logistical challenges exist at this time.[15] One such immunological challenge is maternal antibody interference; however, research indicates cell-mediated immunity is successfully conferred in neonates vaccinated with maternal antibody present.[8] Nevertheless, justification for neonatal vaccination in beef calves is questionable in most cow-calf operations if colostrum is managed appropriately and biosecurity is employed. The management practice known as branding provides a second window of opportunity to vaccinate young beef calves prior to weaning. Calves born in a defined calving interval are typically 60 to 120 days of age at branding. At this time, maternal antibodies begin to wane and immunological maturity is greater than in the neonate; therefore, primary vaccination at branding time is intuitive and research has demonstrated acceptable vaccine efficacy based on humoral immune response. In 2 different studies where the initial MLV respiratory vaccine was administered at branding time, sufficient BVDV-specific antibody responses were noted in vaccinated calves.[6,9] Successful immunization against respiratory pathogens at branding should also reduce the impact of "summer pneumonia", or a BRD outbreak that occurs in pre-weaned calves between branding and weaning which typically occurs during the summer months. Immunization at branding may also result in amnestic responses to viral antigens upon subsequent vaccination during preconditioning.

Vaccination during Preconditioning

Preconditioning is a comprehensive management practice first identified in the 1960s designed to reduce the incidence and susceptibility to BRD during the stocker and feedlot segments of the beef production system. The negative effects of stress are mitigated through preconditioning management; however, this management practice must occur during a critical time period before marketing and transport to a stocker operation or feedlot occurs. Although the specific requirements of different preconditioning programs may vary slightly, typical requirements include weaning calves on their origin ranch for a specified time (i.e. ≥ 45 days), vaccinating against clostridial and respiratory (IBRV, BVDV type 1 & 2, PI3V, BRSV, *Mannheimia haemolytica, Pasteurella multocida, Histophillus somni*) pathogens, treatment with anthelmintic, castration, dehorning, and training to consume feed from a bunk and water from a trough before being marketed or transported to a stocker or feedlot facility.[3] Each of these preconditioning requirements functions to reduce stress and disease risk in preparation for the stocker or feedlot environment. For example, in the preconditioned calf, weaning stress is reduced and overcome on the ranch of origin before

shipping and commingling occurs. This mitigates the additive effect of multiple stressors by shifting a portion of the stress experience earlier (i.e. weaning stress on the ranch of origin rather than during transport to a feedlot with concurrent stressors). Not surprisingly, preconditioned cattle perform better than high-risk cattle; during a 56-day receiving period ADG was 2.6 for preconditioned calves vs 1.9 lb (0.86 kg)/day for high-risk calves procured from auction markets.[11] In the same study, the BRD morbidity rate was 7 and 70% for preconditioned and auction market cattle, respectively. Furthermore, the preconditioned cattle arrived with markedly greater antibody against BVDV, presumably from previous vaccination against BVDV, thus the need for subsequent vaccination is questionable. Because of improved health and performance, preconditioned cattle are more valuable. Net return for preconditioned vs non-preconditioned steers selling in a Kansas auction market from 1999 to 2004 was estimated between $14.28 (winter) and $31.84 (fall)/animal depending on market conditions, calf weight and condition.[2] Whereas, the estimated $40 to $60/animal value of preconditioned cattle in the feedlot is considerably greater than the estimated net return from marketing preconditioned calves.[2] Despite research and veterinarian support, why is it that so few cow-calf producers take advantage of preconditioning and the improved value that it holds? The small average herd size, particularly in the southeastern US, is problematic because economic risk associated with preconditioning is increased. Some producers may have attempted preconditioning in the past, only to find disappointment in morbidity and/or death loss during the preconditioning period or the lack of premium price offered at sale. If preconditioned cattle must be extensively comingled after purchase, the value of preconditioning is diminished.

Post-weaning Vaccination

One of the major components of preconditioning is vaccination, and there are numerous reasons why vaccination during preconditioning, rather than upon feedlot arrival, is advantageous. First, the timing of vaccination during a preconditioning program is appropriate relative to subsequent stress and natural challenge during transition of calves to a stocker or feedlot facility. Vaccine efficacy hinges upon a robust immune response to the antigens contained in the vaccine, and the immune system requires several days to weeks to respond adequately depending on host and antigen-specific factors. Furthermore, stress may alter the immune system's ability to respond to a vaccine and stress is reduced when vaccination is implemented at the ranch origin vs feedlot arrival. Although the current recommendation of feedlot consulting veterinarians is nearly unanimous in favor of vaccination against respiratory viruses during initial processing of high-risk cattle,[14] research does not support this recommendation. Previous field studies have evaluated the timing of vaccination, effects of re-vaccination, or compared different vaccine products; however, a negative control treatment is rarely used. A recent study was conducted in which high-risk calves were vaccinated with a MLV respiratory vaccine on day 0, 14 or a non-vaccinated control group during a 42-day receiving period. Although overall BRD morbidity was not different, the relapse rate was increased for the non-vaccinated cattle and suggests that at least some degree of respiratory vaccine efficiency occurred in this trial. Average daily gain was reduced transiently for either vaccinated group, which may be explained by vaccine-induced stimulation of the acute-phase response, which is both catabolic and metabolically demanding.[1] Route of vaccine administration (intranasal vs intramuscular vs unvaccinated control) was evaluated in newly received beef calves, and no differences in BRD health outcomes were observed.[4] In another study evaluating the timing of MLV vaccine (day 0 or 14 from arrival) in high-risk calves, cattle administered the delayed procedure had slight improvement in health and performance.[10] To provide context and comparative effects of the 2 most common arrival processing procedures used to address animal health, a study was conducted to evaluate high-risk, newly received feedlot cattle administered metaphylaxis with tulathromycin and/or vaccination with a pentavalent MLV on arrival and re-vaccinated 14 days after arrival.[7] The main effect of metaphylaxis was observed to reduce BRD morbidity and increase feed intake and ADG during a 56-day receiving period; however, MLV vaccination did not improve health or performance. Therefore, this study clearly demonstrated positive animal health impact of metaphylaxis, but MLV vaccination did not alter health outcome in this population.

Conclusions

Vaccination remains an important part of the prevention component of the animal health triad. Pre-weaning respiratory vaccination is most desirable because the timing is appropriate, and veterinarians should continue to promote pre-weaning vaccination against respiratory pathogens to their clients. The efficacy and efficiency of post-weaning vaccination is less clear, and further research is needed to support (or refute) the nearly unanimous recommendation of respiratory vaccination during initial feedlot processing by consulting feedlot veterinarians. The timing of post-weaning vaccination is less desirable, because concerns exist with the interplay of immunization, stress-induced immune dysfunction, and natural virus challenge that are more likely to exist after weaning.

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