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Effects of Respiratory Vaccination Timing and Hormonal Growth Implant on Health, Performance, and Immunity of Newly Received Stocker Calves

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EFFECTS OF RESPIRATORY VACCINATION TIMING AND HORMONAL GROWTH IMPLANT ON HEALTH, PERFORMANCE, AND IMMUNITY OF NEWLY RECEIVED STOCKER CALVES

EFFECTS OF RESPIRATORY VACCINATION TIMING AND HORMONAL GROWTH IMPLANT ON HEALTH, PERFORMANCE, AND IMMUNITY OF NEWLY RECEIVED STOCKER CALVES

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ABSTRACT

Stress alters the immune system and vaccination during this time may reduce vaccine response; whereas, growth implants may shift metabolism to enhance tissue deposition in exchange for energy required for immune response during bovine respiratory disease (BRD) challenge. This study was conducted to determine the effects of pentavalent respiratory vaccination timing with or without a hormonal growth implant on arrival (d 0) on health, performance, complete blood count, and vaccine response in high–risk, newly received stocker calves during a 42–d receiving period. Crossbred bull and steer calves (n = 385) were weighed (initial BW = 202 ± 4.1 kg), stratified by castrate status on arrival, and assigned randomly to 1 of 4 treatments arranged in a 2 × 2 factorial: 1) arrival (d 0) vaccination, with implant (AVACIMP), 2) arrival vaccination, without implant (AVAC), 3) delayed (d 14) vaccination, with implant (DVACIMP), 4) delayed vaccination, without implant (DVAC). The percentage of calves treated for BRD once, twice, or thrice was 80, 50 and 20%, respectively, but did not differ ($P \geq 0.12$) among treatments. Likewise, days to initial BRD treatment was not affected by vaccine timing ($P = 0.66$) or implant ($P = 0.24$). Overall ADG (d 0 to 42) did not differ due to vaccination timing ($P = 0.53$) or implant ($P = 0.64$). White blood cell count was not different ($P \geq 0.76$) among treatments, but exhibited a cubic response over time ($P = 0.01$), with counts increasing from d 0 to d 28 prior to leveling off at the end of receiving (d 42). The neutrophil:lymphocyte ratio decreased (linear, $P < 0.0001$) throughout receiving. Bovine viral diarrhea virus type 1a antibody concentrations were greater ($P = 0.02$) for calves vaccinated on arrival and increased over time for both vaccine treatments ($P = 0.01$). Results indicate a hormonal growth implant administered on–arrival to high–risk stocker calves did not increase ADG. Morbidity rate was high but was

not impacted by vaccine timing or implant. Vaccination on arrival increased bovine viral diarrhea virus type 1a antibody concentrations throughout receiving.

This thesis is approved for recommendation

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DEDICATION

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CHAPTER I:

INTRODUCTION

Morbidity and mortality from bovine respiratory disease (BRD) in newly weaned beef cattle continue to be the among the largest health problems facing the US beef cattle industry (Duff and Galyean, 2007). Prevention of BRD is important in order to limit the economic ramifications of BRD (Schneider et al., 2010). Cattle are classified as low, medium, or high risk for BRD based on the existence of predisposing factors to the disease. High-risk cattle are of unknown origin or background, have been commingled and purchased at local sale barns, and are transported various distances to purchasers. These cattle are more susceptible to BRD because they have not likely been vaccinated prior to commingling with exposed cattle during the marketing process, are exposed to stress and environmental changes associated with marketing, and have a lower plane of nutrition for varying periods of time following marketing (Step et al., 2008).

Treatments using antibiotics as a preventative measure has decreased the incidence of BRD in high-risk beef cattle (Duff and Galyean, 2007); however, vaccination during processing on arrival may not allow adequate time to develop an immune response (Callan, 2001; Richeson et al., 2009). Stress may compromise the immune system, while previous exposure to disease may further reduce vaccine efficacy (Richeson et al., 2009) and animal performance. Delaying vaccination against BRD may allow high-risk cattle to overcome stress associated with weaning, and changes in feed and environment potentially allow a better response to vaccination. To date results from such approaches have been mixed. In two receiving studies by Richeson et al. (2008,

2009), delaying BRD vaccination 14-d improved health and performance in one study but had no effect on the second.

Cattle are often implanted on arrival to improve performance during the receiving phase. Implants improve production gains, efficiencies, and yield of product in beef cattle finishing programs (Elam et al., 2009), and act to increase protein deposition (Baxa et al., 2010). Hormonal implants are used throughout each phase of beef cattle production (Mader, 1997); however, response to implants may be lower when several are used at various stages (Mader, 1994).

Further investigation of management strategies to reduce BRD incidence would limit associated cost, increasing economic returns for producers (Step et al., 2008). Use of implants in receiving cattle is among those production strategies heavily used in receiving cattle management. Serum concentrations of estradiol-17 beta peaked between d 0 and 14 of receiving in cattle implanted on arrival (Bryant et al., 2010), the period of highest stress in receiving cattle. Thus, the objective of this study was to determine the effects of BRD vaccination timing (d 0 or 14) with or without growth implant on arrival on health, performance, bovine viral diarrhea virus type 1a antibody concentrations, and immune measures of newly received beef calves.

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Chapter II:

LITERATURE REVIEW

Bovine Respiratory Disease

Bovine respiratory disease **(BRD)** complex is among the largest health obstacles the cattle industry faces because of the high cost associated with management and treatment (Schneider et al., 2009). Cost of BRD results from morbidity, and mortality, but also from production losses measured by decreased average daily gain, expense of vaccine treatments, and additional labor costs of treating and managing sick cattle. New vaccines and antimicrobials have been introduced; however, BRD rates have not decreased overtime (Babcock et al., 2006), possibly because of the lack of use of preconditioning programs prior to marketing.

Cow-calf producers in the Southeast United States historically fail to implement preconditioning programs including vaccination and management practices that can decrease the incidence of BRD in their cattle (NAHMS, 1997). In 2007, 61% of operations did not vaccinate beef calves for respiratory disease prior to leaving the farm for marketing. Calves that were not vaccinated made up 31% of the total calves sold in the United States (NAHMS, 2008a).Thus, management of BRD by stocker cattle producers is important on arrival to improve immune status prior to feedlot entry. According to Chirase and Greene (2001), BRD has been reported to cost the industry up to $750 million annually. With increasing feed and cost of hired labor, this estimated expense will continue to increase over time.

Bovine respiratory disease involves the interaction of various infectious agents (infectious bovine rhinotracheitis, parainfluenza-3, bovine viral diarrhea virus, bovine respiratory

syncytial virus, *Mannheimia haemolytica*, *Pasteurella multocida*, and *Histophilus somni*), as well as environmental conditions, and stress from handling, management, and US marketing procedures (Galyean et al., 1999, Taylor et al., 2010). These infectious agents work together and target cattle at the receiving stage when stress is greatest. Stress associated with weaning and receiving can affect calf health and performance by suppressing immune function, increasing the risk from exposure to infectious agents , causing a combination of viral and bacterial infections (Arthington et al., 2008). Cattle that are commingled with unfamiliar cattle in an auction market setting are exposed to viral and bacterial agents and are at high risk for developing BRD.

Predisposing Factors of BRD. Pre-weaning factors that contribute to BRD include poor nutritional status of the calf, lack of vaccination, and failure to wean calves prior to transportation and marketing. Stressed cattle will not consume feed and water comparable to healthy unstressed cattle (Cole, 1996), and this reduction in nutrient intake and dehydration may also affect the immune system, resulting in increased morbidity and mortality (Duff and Galyean, 2007). Shipping and processing calves enhances predisposing factors by exposure to unsuitable environmental conditions and stress (Snowder et al., 2006). Calves are more susceptible to infectious agents when stress alters the respiratory mucosa of the calf, negatively affecting the immune system directly or through the effects of endogenous agents such as cortisol (Taylor et al., 2010).

Classification of cattle into risk categories for BRD is common for receiving cattle management (Richeson et al., 2009). This strategy gauges the potential for cattle to contract BRD based on several factors prior to and post weaning. High-risk cattle are of unknown origin with no record of vaccination, seldom weaned prior to transportation to the sale barn, and are

commingled with calves of various origins during marketing. Level of stress, effect of stress on overall immunity, and exposure to infectious pathogens with no vaccination to prevent illness increase the incidence of BRD. During marketing cattle suffer from feed and water deprivation and are commingled with unfamiliar cattle exposing them to a greater amount of viral and bacterial pathogens, thus increasing the chances of contracting combinations of viral pathogens associated with BRD. Through the weaning and marketing process, calves may shrink as much as 10% or more depending on the overall disposition of cattle, distance to stocker facility, and adequacy of personnel to manage incoming cattle (Thrift and Thrift, 2011). Receiving management includes all strategies involved in processing and treating incoming sale barn stocker cattle with no previous records. Castration, dehorning, and vaccination are common procedures done at a time when cattle are already stressed from weaning and marketing.

Viral and Bacterial Agents. Viral agents play a key role in initiating the BRD complex, acting as a primary challenge to the respiratory tract. Viruses are believed to predispose bacterial infection in 2 ways: 1) by directly damaging the clearance mechanisms of the respiratory system, and 2) by bacteria relocating from the upper respiratory tract into the already compromised portion of the lung (Taylor et al., 2010). Viral agents including infectious bovine rhinotraceitis (**IBR**), parainfluenza-3 (**PI3**), bovine viral diarrhea virus (**BVDV**), bovine respiratory syncytial virus (**BRSV**), and bovine enteric coronavirus have been associated with BRD in feedlot calves (Plummer et al., 2004).

Infectious bovine rhinotracheitis is a herpes virus also known as bovine herpes virus 1, and commonly called red nose. An infection in the upper respiratory tract occurs in most groups of cattle with lowered immunity that have not been previously exposed to the disease. Symptoms of IBR include lesions on the muzzle, nasal discharge, runny eyes, coughing, lack of appetite,

and labored breathing, elevated temperature, ulcers in the upper respiratory tract, and destruction of the corpus luteum causing abortion. Viruses can spread by direct contact, breeding, *in utero*, during birth, and in airborne particles. Stressed animals shed the virus more rapidly increasing the issue of virus spread (Patel, 2005).

The presence of BVDV may cause decreased fertility, abortions, congenital malformations, and intrauterine infections causing calves to be born persistently infected (**PI**) (Taylor et al. 2010). Calves that are infected with non-cytopathic BVDV from d 40 to d 125 of gestation will become immunotolerant and shed large quantities of BVDV for the remainder of their life and will not respond to vaccination (Duff and Galyean, 2007). According to a USDA survey, only 9% of operations had a calf that tested positive for PI BVDV and 0.12% of all calves tested were found to be positive via the ear notch test, but one calf can cause a great amount of morbidity within a herd. Testing for PI-BVDV, and removing infected calves will improve the health of other cattle in the same group (NAHMS, 2008b). The immune system responds to the persistent infection in order to control it but is not able to eradicate the disease, explaining the lack of symptoms of BRD in PI calves (Abbas et al., 2010).

Bovine viral diarrhea virus is classified into 2 genotypes based on sequences from the 5' untranslated region of the viral genome and are further characterized into subgenotypes 1 a, 2 b, 2 a, and 2 b; furthermore, BVD is also classified into two biotypes which are cytopathic, a strain of BVDV that kills epithelial cells when cultured in vitro and non-cytopathic, a strain that does not kill epithelial cells when cultured in vitro (NAHMS, 2008b).

The BVDV is unique in that it can cause an intrauterine infection resulting in PI calves. Millions of viral pathogens can thus be spread to cattle commingled with PI calves. Persistently

infected calves are a main source of disease in feedlots (O'Connor et al., 2005). The number of calves that are persistently infected is low, but one animal sheds millions of viral pathogens and can expose an entire pen to BVDV. The economic impact of PI calves may be high due to the potential for a greater exposure within the herd (Duff and Galyean, 2007). Most vaccines may not provide adequate protection against BVDV1b (Fulton et al., 2006). In a study by Longeragen et al. (2005), PI animals increased the risk of antimicrobial treatment for BRD by 43% compared to animals not exposed. Regardless of biotype or genotype, significant losses can occur in cattle infected with the viral agent with increased effects if all other predisposing factors are also present (Duff and Galyean, 2007).

Wittum et al. (1996) screened 18,931 calves in 128 beef herds in 5 states for PI-BVDV. On the initial screening, 56 BVDV positive calves were found in 13 herds and 61% of the calves remained positive at 6 mo of age. According to Fulton et al. (2005), 1 PI calf caused 68.4% of morbidity in commingled calves.

Mannheimia haemolytica, *Pasteurella multocida*, and *Histophilus somni* are bacterial pathogens of primary concern with *Mannheimia haemolytica* serotype 1 being the organism most commonly associated with BRD (Pandher et al., 1998). *Mycoplasma bovis* is a bacterial agent that has recently become associated with those in the BRD complex. It is known to consistently cause chronic poor doers (Taylor et al., 2010). *Pasteurella multocida* is carried by many normal cattle and becomes a problem in combination with other agents. Cattle with *H. somni* show few clinical signs unless other systems are affected as with brain fever, also known as thromboembolic meningioencephalitis (TEME).

Signs and Clinical Symptoms of BRD. Health, the overall well-being of an animal, is determined by visual assessment of an animal by producers or personnel as well as further clinical measurements to confirm diagnosis of particular diseases. Initial assessment of health is often subjective and can be misjudged depending on the experience of the evaluator. Symptoms can be in any combination and may be harder to detect in cattle attempting to blend in with the herd. Because of a heavy reliance on visual signs for determining BRD, there is a high potential for incorrect diagnosis at this time (Galyean et al., 1999).

Signs of BRD include evidence of depression such as hanging head, sunken or glazed eyes, slow movement, arched back, difficulty in rising, knuckling or dragging toes when walking, and stumbling. Abnormal appetite is often seen in addition to depression caused by respiratory distress. Animals can be completely off feed, eat less than or with less aggression than other animals, have lack of fill, or obvious BW loss. Morbid steers spend 30% less time at the feed bunk than healthy steers (Sewell et al., 1999). Respiratory signs of BRD include obvious labored breathing, extended head and neck, and noise when breathing.

Diagnosis of BRD is less than optimal and a cost-effective method to more accurately detect infected animals or animals that are likely to develop BRD would be valuable (Duff and Galyean, 2007). Studies have shown that serum concentrations of haptoglobin on arrival were increased in steers that required more than one antimicrobial treatment (Carter et al., 2002; Berry et al., 2004). Serum haptoglobin measured on arrival may potentially be used as a predictor of clinical BRD. Serum haptoglobin concentrations were greater in auction market steers and steers weaned directly prior to shipping than preconditioned steers and arrival serum haptoglobin

concentrations were greater for steers requiring a greater number of treatments in a more recent study, agreeing with previous research (Step et al., 2008).

Preconditioning

Preconditioning is a method used by cow-calf producers to improve overall cattle health and gain performance by limiting stress, increasing feed intake at receiving, and reducing BRD at subsequent stages of beef cattle production. This management concept was developed to allow for a period of adjustment from weaning stress in order to improve the immune response of calves prior to the likely exposure to BRD pathogens during marketing and commingling (Thrift and Thrift, 2011).Most beef cattle are weaned immediately prior to marketing which can be one of the biggest stress factors for a calf (Boyles et al., 2007). Implementing a preconditioning program would allow for an adjustment period and alleviate this stress.

Various programs have been developed and established with specific requirements for number of days weaned prior to sale, vaccination requirements, and calf identification. Cattle are preconditioned while still at their place of origin for 30- to 45- d post-weaning, depending on requirements of the program; however, periods of less than 30- d do not allow for enough gain for preconditioning to be cost effective for cow-calf producers (Thrift and Thrift, 2011).

Typical preconditioning requirements include administration of parasiticids, vaccination against bacterial and viral pathogens with initial as well as booster vaccinations, dehorning, castration, and adjustment to feed bunks and water sources (Duff and Galyean, 2007). Vaccination programs used include 7- or 8- way clostridial vaccination, 4- or 5-way viral vaccine including IBR, PI-3, BVDV, and BRSV, *Mannheimia haemolytica*, *Pasteurella multicocida*, and

Histophilus somni are also included. Some vaccinations can be purchased in combination such as a 7-way clostridial vaccine including vaccination against bacterial agents. Administering a clostridial vaccination without also vaccinating calves for BRD pathogens will stimulate the immune system but will not prevent contracting BRD (Thrift and Thrift, 2011).

Duff and Galyean (2007) found that preconditioning programs including pre-weaning viral vaccination programs, along with male castration, significantly decreased BRD in the feedlot. However, according to a USDA survey of cow-calf management practices (NAHMS, 2008a), 56.1% of operations in the south central United States did not castrate bull calves before marketing. Daniels et al. (2000) found that calves castrated upon arrival to the feedlot had a greater incidence of morbidity than calves that were castrated before arrival (35.8 vs, 18.6%). Mortality was also greater for calves castrated upon arrival compared to calves castrated before arrival.

Step et al. (2008) conducted a trial that included three treatments of cattle received from a single source ranch that were 1) weaned 45 d prior to receiving, 2) weaned as well as vaccinated, or 3) weaned and immediately shipped, and compared these to auction market calves. Calves of ranch origin were less likely to be treated for BRD than those purchased through auction markets. Calves that were kept on the ranch 45 d after weaning were also less likely to develop BRD than market calves or calves directly received after weaning. Calves from a single source that are retained on the ranch for 45 d after weaning exhibit less morbidity and less health costs during the receiving period and at the feedlot than when cattle are commingled or trucked to the feedlot immediately after weaning (Step et al., 2008). Preconditioning improves health status of the animal and reduces the costly incidence of BRD throughout the feedlot phase.

Cost associated with BRD. Despite improved vaccines and antimicrobials, BRD rates have been increasing (Loneragen et al., 2005; Babcock et al., 2006; Holland et al., 2010) during recent years. In a recent study, Holland et al. (2010) used 360 British and British x Continental heifers assembled at the Western Kentucky Livestock Auction (Marion), and transported 957 km to Stillwater, OK to determine the effects of segregation and commingling. The newly received heifer calves were sorted into BRD-outcome groups to determine the effect on feedlot performance and carcass characteristics when heifers were fed to a similar carcass compositional endpoint. After the 63 d preconditioning phase, there was a linear decrease in BW as the number of treatments for BRD increased from 0 to 3. Body weight was 30 kg less for CI heifers than heifers treated 3 times for BRD. Similar decreases were seen during finishing and there was a 35 kg difference between CI heifers and those treated 3 times and remained large at the end of the 122 d finishing phase. Clinically ill heifers were 29 kg lighter than heifers treated 3 times, immediately before slaughter which contributes to the cost of BRD. Average daily gain declined linearly when including the preconditioning period as number of treatments for BRD increased. The overall ADG of CI heifers was less than those treated 3 times. According to Fulton et al. (2002) feedlot cattle that received 1, 2, and 3 treatments for BRD returned $40.64, $58.35, and $291.93 less, respectively, than untreated animals.

Loss of economic return is due to decreased carcass weight and reduced quality grade along with treatment costs (Gardner et al., 1999). In this study, a 4% decrease in ADG, 1.7% decrease in final BW, and a 2.6% decrease in HCW were reported for steers treated for BRD than for untreated steers. During a 1999 feedlot study, the average treatment cost was $12.59 with 14.4% of cattle being treated (USDA, 2000). The cost of BRD reaches $92.26 when reduced ADG and lower carcass value are considered (McNeill et al., 1996).

Morbidity and Mortality of BRD. Bovine respiratory disease is the leading cause of morbidity and mortality according to a recent survey of US feedlots (Woolums et al., 2005). Bovine respiratory disease accounts for 70% to 80% of total morbidity and 40% to 50% of mortality (Smith et al., 1998).Timing of BRD treatment can be crucial in limiting results of the complex in the cattle industry.

Holland et al. (2010) reported morbidity from BRD clinical signs were 57.6% falling within range of expected morbidity rates for calves with similar background in various other studies. Total mortality was 8.6% in this study. In recent experiments at the University of Arkansas using auction market cattle. Richeson et al. (2009) found similar morbidity from auction market cattle with 69% of cattle treated for BRD at least one time, and 1.9% death loss. In that study, morbidity ranged from 2.5% to 64%. Cattle were treated with clostridial and respiratory vaccination on arrival (ACAR), clostridial on arrival and respiratory vaccination delayed 14 d (ACDR), delayed clostridial 14 d with respiratory vaccination on arrival (DCAR), or delayed clostridial and delayed respiratory vaccination (DCDR). Morbidity and mortality rates did not differ due to treatment.

Timing of morbidity is also a factor in treatment. Thompson et al. (2006) found that 87% of first treatments occurred within the first 35 d. Disease timing, when measured relative to arrival and slaughter, affects performance and health outcomes. Management prior to entry into the stocker phase of production is also a variable when determining causes of increased morbidity and mortality. Different management strategies could be developed after insight into the relationship between BRD timing and variables of performance and health (Babcock et al., 2006).

Longer transport distances for arriving calves were associated with an increased morbidity incidence. It is thought that increased stress is associated with the longer transit time but little data supports this at this time (Sanderson et al., 2008). Concentrations of plasma glucose and lactate in cattle may be affected by the health status of incoming cattle. Plasma glucose concentrations of heifers were linear with greatest concentrations for heifers never treated for BRD, and decreased for heifers treated. Plasma glucose was least when cattle were treated 3 times for BRD and considered morbid. This may have been due to disease challenge before processing (Montgomery et al., 2009).

Current Preventative and Treatment Protocol for BRD. Ensuring prevention of BRD is extremely important to avoid an epidemic outbreak and compounding economic cost associated with BRD (Schneider et al., 2010). Routine monitoring of the cow herd for potential viral or bacterial immunogens, or both, and administering annual boosters to the cows might result in transfer of greater levels of antibodies to the calves (Duff and Galyean, 2007). Also, Zimmerman et al. (2006) reported that a single dose of a modified live vaccine (MLV) containing BVDV administered at 4 to 5 wk of age stimulates a strong protective immune response against BVDV in calves. Vaccination is the most effective method for preventing and treating infections (Abbas et al., 2010).

One common treatment protocol is if body temperature exceeds 104˚ F and clinical signs are exhibited for the disease, the animal should be treated using proper antibiotics. Antibiotics are the most effective method for treating infections (Abbas et al., 2010). After administering an antibiotic, the calf should be rechecked in 48 to 72 hr. If the calf is continuing to show clinical symptoms a second antibiotic can be administered. If the calf continues to show signs of BRD

and is not responding to antibiotics after a third treatment is administered, the calf is then considered chronic for the disease.

According to Daniels et al. (2000), fewer calves were found to be morbid if administered a metaphylactic treatment of tilmicosin or florfenicol on arrival to the feedlot than control calves, however; it was not reported if risk was assessed. Hoar et al. (1998) used 220 feedlot calves diagnosed with BRD to compare the efficacy of tilmicosin administered once, and florfenicol administered twice at 48-h intervals to treat BRD and found that response to either therapy was similar. There is concern with cost of treatment and the potential overuse of antibiotics creating drug resistance (Hoar et al., 1998).

The difference between vaccination and immunization can be confused. Vaccines are antigens along with adjuvant mixtures administered to induce protective immunity against microbial infections. Vaccines can be in the form of live avirulent or killed microorganisms to stimulate an immune response. Immunization is the successful establishment of an immune response to protect against infection caused by the vaccine administered. Immunity is the reaction of an animal's immune system to a foreign substance, to protect against infectious disease. Immunity can be acquired by vaccination or from previous exposure to the virus or bacteria (Abbas et al., 2010).Vaccination does not ensure immunization will occur, and protection from disease is not guaranteed (Callan, 2001). It is desired for cattle to develop immunity to BRD and this immunity should occur after vaccination to limit losses in production.

Given that BRD is a major problem for the beef industry, it seems logical that the industry should address BRD through genetics as well as management strategies (Thrift and Thrift, 2011). Genetic selection would be a slow process according to Snowder et al. (2006);

thus, if BRD is reduced in North America, it will be achieved most easily by specific changes in management techniques (Thrift and Thrift, 2011).

Delaying Vaccination in Receiving Cattle. Stress, commonly associated with weaning, marketing, and shipment of feeder cattle, can compromise immune function, and vaccine administration during immunosuppression may reduce vaccine efficacy and performance (Richeson et al., 2008) throughout receiving and into the feedlot phase of production. Results for delayed vaccination studies vary resulting in different opinions and ideas for managing stressed cattle.

Previous exposure to BRD pathogens may decrease efficacy of vaccination (Richeson et al., 2009) if administered on arrival at a stocker facility. In high-risk calves, the transportation stress period can endure for as long as 15 d post-arrival based on serum haptaglobin concentration of calves (Purdy et al., 2000). Much of the failure of vaccination may be timing of administration, failure of stressed calves to respond appropriately to vaccination, the multifactorial nature of BRD, and the increased susceptibility of stressed calves to all pathogens. This has introduced the idea of delaying processing until cattle have adjusted to the new environment and are alleviated of stress (Taylor et al., 2010).

In a study by Richeson et al. (2008) calves were assigned to one of two BRD vaccination treatments. Cattle were either vaccinated with a multivalent modified live virus (MLV) BRD vaccine on arrival (d 0) or delayed 14-d. Body weights were collected for performance data, morbidity was used to determine health, and blood samples were drawn for serum IBR antibody levels. Average daily gain was greater for calves delayed vaccination from d 0 to d 14 (DMLV) and throughout the entire receiving study from d 0 to d 42. Morbidity rates for BRD were high

for all cattle but were unaffected by vaccination treatment along with days to first treatment, treatment cost, and mortality. Positive IBR antibody seroconversion was greater for DMLV calves on d 42 of the trial as well as d 28 and d 42 post vaccination, suggesting an improved immune response by delaying BRD vaccination 14-d.

Richeson et al. (2009) found that BRD and clostridial vaccination timing did not affect ADG or morbidity of calves during the 56-d receiving period. Days to first treatment for BRD were less for cattle vaccinated with both clostridial and BRD vaccinations on arrival than cattle receiving delayed vaccinations. Cattle that received BRD vaccination on arrival developed greater BVDV type 1 antibody concentrations than delayed BRD vaccination.

Use of Implants. The U.S. beef cattle industry currently uses growth-promoting implants as a common management practice to increase growth and reduce costs by improving feed efficiency of cattle (Roeber et al., 2000, Platter et al., 2003). Nutrition and management practices such as implanting that influence maintenance energy requirements could improve efficiency and decrease the cost of beef production in the U.S (Paisley et al., 1999).

Implants work by slowly releasing growth stimulants over a period of time by increasing circulating levels of somatotropin and insulin-like growth-factor 1. This increase in circulating hormones increases the secretion of growth hormone, increasing muscle growth. Zeranol implants are synthetic estrogen implants, affecting female characteristics. The growth response will be greater for calves fed a higher plane of nutrition (Stewart, 2010).

Steroidal hormones such as trenbolone acetate and estradiol and β-adrenergic agonists such as ractopamine hydrochloride and zilpaterol hydrochloride, improve production gains, feed efficiencies, and yield of product (Elam et al., 2009). Zeranol is an implant derived from mold

found on corn by *Gibberella zeae*. During 25 trials by the manufacturer, Ralgro increased the rate of gain of feedlot steers by 9.3 and 10.3% without any differences in carcass traits when fed the same number of days compared to untreated cattle. Implanted cattle were heavier at slaughter than cattle that were not implanted (Sewell, 1993).

Hormonal implants may be used prior to weaning, during the growing phase, and into finishing phases of cattle production (Mader, 1997; Platter et al., 2003). However, cumulative implant response may be lower when several implants are used at various stages of production (Mader et al., 1994). Mader et al. (1994) reported that cattle implanted post-weaning had increased dry matter intakes when placed directly in feedlots.

Serum concentrations of estradiol-17β increase within 14-d after receiving the initial implant (Bryant et al., 2010) while stress is also high. This stress may reduce the efficacy of the implant administered at the beginning of the receiving period. If energy is partitioned for growth, this partitioning may alter immune function during a period when immune status is important after exposure to stress and various viral and bacterial agents during marketing and processing. Anabolic hormones may potentially modify metabolism to enhance growth and reduce energy that is required for immune function at this time. Implanting on arrival may decrease the efficacy due to stress and energy repartitioning, and increase morbidity by compromising the function of the immune system.

A study was conducted to determine the effects of delaying BRD vaccination 14-d with or without a hormonal growth implant to determine the effects on health, performance, and immunity of newly received stocker calves. This study considered the problem with BRD that the US beef market faces, and the lack of preconditioning programs including vaccination of BRD prior to marketing and exposure to various pathogens. Current management strategies

include implanting on arrival to the stocker unit; however, little is known of the effect that implanting has on health and immune function of the calf during a high period of stress. Research was conducted to determine if delaying vaccination with or without implanting on arrival is efficacious to the overall health and BW gain performance of the calf.

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CHAPTER III:

MASTER'S THESIS

Effects of respiratory vaccination timing and hormonal growth implant on health, performance, and immunity of high-risk, newly received stocker cattle

ABSTRACT

Stress alters the immune system and vaccination during this time may reduce vaccine response; whereas, growth implants may shift metabolism to enhance tissue deposition in exchange for energy required for immune response during bovine respiratory disease (BRD) challenge. This study was conducted to determine the effects of pentavalent respiratory vaccination timing with or without a hormonal growth implant on arrival (d 0) on health, performance, complete blood count, and vaccine response in high–risk, newly received stocker calves during a 42–d receiving period. Crossbred bull and steer calves (n = 385) were weighed (initial BW = 202 ± 4.1 kg), stratified by castrate status on arrival, and assigned randomly to 1 of 4 treatments arranged in a 2 × 2 factorial: 1) arrival (d 0) vaccination, with implant (AVACIMP), 2) arrival vaccination, without implant (AVAC), 3) delayed (d 14) vaccination, with implant (DVACIMP), 4) delayed vaccination, without implant (DVAC). The percentage of calves treated for BRD once, twice, or thrice was 80, 50 and 20%, respectively, but did not differ ($P \geq 0.12$) among treatments. Likewise, days to initial BRD treatment were not affected by vaccine timing ($P = 0.66$) or implant ($P = 0.24$). Overall ADG (d 0 to 42) did not differ due to vaccination timing ($P = 0.53$) or implant ($P = 0.64$). White blood cell count was not different ($P \geq 0.76$) among treatments, but exhibited a cubic response over time ($P = 0.01$), with counts increasing from d 0 to d 28 prior to leveling off at the end of receiving (d 42). The neutrophil:lymphocyte

ratio decreased (linear, $P < 0.0001$) throughout receiving. Bovine viral diarrhea virus type 1a antibody concentrations were greater ($P = 0.02$) for calves vaccinated on arrival and increased over time for both vaccine treatments ($P = 0.01$). Results indicate a hormonal growth implant administered on–arrival to high–risk stocker calves did not increase ADG. Morbidity rate was high but was not impacted by vaccine timing or implant. Vaccination on arrival increased bovine viral diarrhea virus type 1a antibody concentrations throughout receiving.

Key Words: health, implant, management, receiving cattle, vaccine

INTRODUCTION

Morbidity and mortality from bovine respiratory disease (BRD) in newly weaned beef cattle remains among the most frequent health problems facing the US beef industry (Duff and Galyean, 2007). Cattle are classified as low, medium, or high risk for BRD based on predisposing factors to the disease. High-risk cattle are of unknown origin or background, have been commingled, purchased at local sale barns, and transported various distances following purchase. These cattle are considered more susceptible to BRD because they have not likely been vaccinated and are commingled with exposed cattle during marketing (Smith, 2004).

Treatments using antibiotics as a preventative measure have decreased the incidence of BRD in high-risk beef cattle (Duff and Galyean, 2007); however, other treatments such as vaccination during processing on arrival may not allow for time to develop an immune response (Callan, 2001). At this time stress may compromise the immune system, while exposure to BRD pathogens during marketing and transport may further reduce vaccine efficacy and calf performance (Richeson et al., 2009). While preweaning BRD vaccination is preferred, high-risk

newly-received calves that are allowed a period to recover from stress may respond more appropriately to modified-live virus BRD vaccination (Richeson et al., 2008). Delaying vaccination against BRD would allow high-risk cattle to overcome stress associated with weaning, and changes in feed and environment in order to better respond to vaccination. Results have been inconsistent in previous studies. In one study by Richeson et al. (2008), delaying BRD vaccination 14-d improved health and performance while in a second study (Richeson et al., 2009) no improvements were observed.

Stocker calves respond to implants by improving daily BW gains. Cattle are implanted on arrival at stocker units to improve performance during the receiving phase. Implants improve production gains, feed efficiencies, yield of product in beef cattle finishing programs (Elam et al., 2009), and act to increase protein deposition (Baxa et al., 2010). Immune stimulation can result in decreased growth of an animal because nutrients are utilized for the immune system as priority over growth (Spurlock, 1997). Implanting may repartition the use of nutrients away from the immune system to growth and muscle deposition.

Further investigation of management strategies to decrease the incidence of BRD would likely reduce associated cost, increasing economic returns (Step et al., 2008). Implanting is among the management strategies widely used in receiving cattle management. Serum concentrations of estradiol-17 beta peaked between d 0 and 14 of receiving in implanted cattle (Bryant et al., 2010), during the period of highest stress for receiving cattle. Thus, the objective of this study was to determine the effects of BRD vaccination timing (d 0 or 14) with or without growth implant on arrival on health, performance, bovine viral diarrhea virus type 1antibody concentrations, and immune measures of newly received beef calves.

MATERIALS AND METHODS

Animals and Management

Animal methods were approved by the University of Arkansas Institutional Animal Care and Use Committee. A total of 385 high-risk crossbred bull and steer calves (initial BW = 202 ± 4.1 kg) were purchased from a northern Arkansas auction barn and shipped to the University of Arkansas, Livestock and Forestry Research Station (**LFRS**), near Batesville, AR. Calves were received on 3 separate dates as each block in the experimental model: Sept. 13, 2010 (block 1, n = 175, 12 pens); Jan. 11, 2011 (block 2, n = 120, 8 pens); and Jan. 31, 2011 (block 3, n = 90, 5 pens) and were divided into 12 total pens with 13 to 16 calves/pen. Each of the 4 treatments was replicated a total of 6 times (block 1, n = 3 pens/trt; block 2, n = 2 pens/trt; block 3, n = 1 pen/trt).

Treatment

Upon arrival (d 0), calves were weighed, and individually identified, and assigned to 1 of 4 vaccination and implant treatment strategies equally distributed by on-arrival castrate status, and BW on arrival (d 0). Treatments included: 1) arrival BRD vaccination (d 0) with implant (AVACIMP) 2) arrival vaccination (d 0) without implant (AVAC) 3) delayed vaccination (d 14) with implant (DVACIMP), and 4) delayed vaccination (d 14) without implant (DVAC).

Vaccination treatment was administered on arrival or delayed 14-d with a 5-way modified-live BRD vaccine injection (Bovi-Shield GOLD®5, Pfizer Animal Health, New York, NY). Booster vaccination was administered 14-d post initial vaccination. Calves were implanted on arrival with zeranol (Ralgro®, Intervet Schering-Plough Animal Health, Millsboro, DE), or not implanted based on assigned treatment group.

Calves were treated on arrival (d 0) for internal and external parasites with moxidectin pour on (Cydectin®, Fort Dodge Animal Health, Fort Dodge, IA), vaccinated using an 8-way clostridial (Covexin-8 ®, Intervet Schering-Plough Animal Health), and bulls were castrated by banding (California Bander®, InoSol, Co. LLC, El Centro, CA). Rectal temperature was measured (Model No. M216®, GLA Agricultural Electronics, San Luis Obispo, CA) at receiving, and calves were treated during initial processing when restrained in the chute using florfenicol and flumexine meglumine (Resflor®, Intervet Schering-Plough Animal Health) if considered morbid based on a rectal temperature ≥ 40°C.

Cattle were observed each morning (0800) by experienced LFRS personnel for visual symptoms of respiratory illness. Personnel were not blinded to treatment, but cattle were not identified based on treatment during observation. Rectal temperature was taken for cattle exhibiting ≥ 2 visual symptoms of BRD and treatment was administered if rectal temperature exceeded 40° C. Treatment protocol included initial treatment with florfenicol and flumexine meglumine (Resflor®, Intervet Schering-Plough Animal Health). A second antibiotic treatment with tilmicosin (Micotil®, Elanco Animal Health, Indianapolis, IN) was administered if calves were still determined morbid by observation 72 h after initial treatment. Cattle requiring third antibiotic were administered enrofloxacin (Baytril®, Bayer Animal Health, Shawnee Mission, KS). Cattle were considered clinically morbid for BRD if not responsive to the third treatment and were given a final antibiotic treatment using tulathromycin (Draxxin®,Pfizer Animal Health).

Blood Sampling and Analysis

Blood samples were collected via jugular venipuncture on d 0, 14, 28, and 42 using 10 mL vacuum tubes containing EDTA (BD Inc., Franklin Lakes, NJ) to determine total and

differential white blood cell (WBC) concentrations, and untreated tubes to determine BVDV type 1a antibody virus neutralization (VN). Whole blood was chilled immediately and refrigerated within 5 h. Total WBC concentrations and differential WBC (lymphocytes, neutrophils, monocytes, eosinophils, and basophils) percentages, total red blood cells, hemoglobin, hematocrit, and platelets were determined within 24 h of collection using an automated hematology analyzer (Cell-Dyn 3500 system, Abbott Laboratoties, Abbot Park, IL) standardized for bovine blood analysis as described by Richeson et al. (2009).

Blood for serum analysis was centrifuged at 2,100 x g for 20 min at 20° C and stored frozen at - 20°C until pooled for shipment and analysis. Serum was pooled by pen to determine BVDV type 1a antibody concentrations using the serum neutralization method described by Rosenbaum et al. (1970), and Richeson et al. (2009), by the Iowa State University College of Veterinary Medicine, Veterinary Diagnostic Laboratory, Ames, IA. The lowest dilution of serum was 1:2 and the greatest was 1:2048. Serum that did not provide protection at the 1:2 concentration levels were reported as < 2 and considered negative for BVDV type 1a antibodies. Serum was considered positive if a $\geq$ 2 value was reported.

Statistical Analysis

Treatment data were analyzed as a 2x2 factorial arrangement of treatments with pen identified as experimental unit. The class statement included block, vaccine treatment, implant treatment, gender, pen, and day. Block and block x pen x vaccine treatment x implant treatment were random effects. The model included vaccine treatment, implant treatment, day, and interactions. Gain performance data were analyzed using PROC MIXED procedure of SAS (SAS Institute Inc., Cary, NC). Date of arrival was the random block effect in the model. Blood

constituent data was analyzed as a repeated measures analysis. Day and treatment x day interactions were included in the model. Pen x block was the subject of the repeated statement for blood constituent analysis. Morbidity data were analyzed using PROC GLIMMIX of SAS. Significance was observed at ($P < 0.05$) and tendencies at ($P < 0.10$). For analysis of antibody concentration levels were transformed by log2 then analyzed for treatment and day effect and treatment x day interactions.

RESULTS AND DISCUSSION

Performance

Performance data are presented in Table 1. There were no differences ($P \geq 0.53$) observed for overall ADG throughout the duration of the 42-d receiving study and no differences ($P \geq 0.16$) for ADG on any day interval throughout the receiving study. These results suggest no performance advantages of implanting or vaccinating receiving cattle on arrival vs delaying vaccination and not implanting during the first 42-d of receiving. There was no negative control in this study; however, DVAC received no treatment during the first 14-d of the receiving period and can be considered a negative control until vaccination as described by Richeson et al. (2008). Overall health of the receiving cattle was poor with 80% initial morbidity, potentially reducing implant efficacy. Upon receiving, cattle were likely recovering from a low plane of nutrition and stress potentially causing physiological changes within the animal. Lack of ADG increase is not typical for normal implanted cattle over non-implanted cattle; however, WBC parameters reported in this study suggest stress, dehydration, and inflammation prior to, during, and after administration of the implant may have reduced the efficacy of the implant by interfering with the growth hormone (GH) axis during the maximum time of hormone release from the implant.

Vaccination timing experiments differ in performance results, potentially due to health status of the calf and differing exposure to agents during the marketing process. Richeson et al. (2008) reported a greater ADG for calves that received a delayed (d 14) bovine respiratory disease vaccination (Express 5®, Boehringer Ingelheim Inc., St. Joseph, MO) while Richeson et al., (2009) reported no effect of vaccination timing on gain performance of the receiving cattle. Another difference among receiving studies includes antibiotics administered for metaphylaxis as well as prophylactic treatment for BRD, creating potential differences in results. In a study by Kreikemeier et al. (1996), cattle were either medicated for BRD or not medicated on either d 1 or 21 of the receiving period including processing strategies with implanting, clostridial vaccinations, and BRD vaccination on either date. Cattle that were processed on d 1 of the study had increased ADG vs cattle that were processed on d 21 differing from our current study where implant had no effect on performance regardless of vaccine strategy.

Clostridial vaccines such as those used in this study contain adjuvants used to enhance immune response to vaccines (Richeson et al., 2008). Effects of the use of clostridial vaccination in combination with BRD vaccination timing should be considered to determine effects on immune response to vaccine as well as efficacy reduction of the implant. Clostridial vaccines used in the current study may have shifted energy focus away from the implant to focus on immune response to overcome BRD morbidity seen on arrival; however, measures of energy metabolism were not done in this study. A study conducted by Chirase et al. (2001) found that cattle not receiving clostridial vaccination performed greater than calves vaccinated. Further research is needed to determine the effect of vaccination timing, implant, and other receiving strategies on morbidity and BW gain of high-risk, newly-received stocker cattle.

Health

Morbidity (Table 2.) did not differ due to vaccine timing ($P \geq 0.59$) or implant treatment ($P \geq 0.35$) but was extremely high, 80% of the total population received initial treatment for symptoms of BRD. Previous delayed vaccination studies showed morbidity rates of 67.5, and 69% respectively (Richeson et al. 2008, 2009). Days to first treatment were < 2, but also did not differ due to study treatments ($P \geq 0.24$). Cattle that were considered morbid and treated for symptoms of BRD were sick and treated on arrival or soon after arrival from the sale barn in the present study. Days to first treatment were low compared to previous research. Richeson et al. (2008, 2009) reported results whereby days to first treatment were ≥ 6 days after receiving. Retreatment of cattle was high with 50.4% of cattle in current study being treated twice compared to 26% of cattle requiring a retreat in the study by Richeson et al. (2008) and 35% reported by Richeson et al. (2009). Cattle requiring a third antibiotic treatment for BRD were 25.4% in the current study which is slightly greater than but similar to Richeson et al. (2009)

There was a numerical difference ($P \geq 0.20$) for cattle treated 3 times for BRD, between AVACIMP and other treatments with 31.7% of AVACIMP cattle treated compared with 19.1% of AVAC, 25.3% of DVACIMP, and 25.5% of DVAC treated three times. Timing of vaccination with or without implant had no effect on morbidity rates of cattle at receiving. Variations in morbidity of receiving cattle may be a result of health and nutritional status on arrival and exposure to pathogens directly prior to arrival resulting in variations in performance.

BVDV Type 1a Antibody Virus Neutralization

There was a vaccination x day interaction ($P = 0.01$) for BVDV type 1a antibody VN (Figure. 1). Titers increased linearly throughout the receiving period for calves vaccinated on arrival. This response is similar to Richeson et al. (2009), reporting BVDV type 1a VN to be greater at d 14 for cattle vaccinated for BRD on arrival with or without a clostridial vaccination than cattle delayed respiratory vaccination 14-d. However, Richeson et al., (2009) also reported that all BVDV type 1 antibody VN were similar by the end of the receiving period (d 42); whereas in the current study, cattle vaccinated on arrival continued to have a greater antibody concentration than delayed vaccination with or without implant. A tendency for a cubic effect ($P = 0.08$) of d post arrival occurred for calves receiving delayed BRD vaccination, titers decreased prior to vaccination followed by an increase similar to calves vaccinated on arrival throughout the receiving period. In Richeson et al. (2009), there was no treatment x day interaction for equivalent days post respiratory vaccination. As reported by Richeson et al. (2009), BVDV antibody concentrations support vaccination on arrival, which allowed a higher antibody response to vaccination than delayed vaccination regardless of stress on arrival at the beginning of the receiving period. Vaccine efficacy is dependent on antibody production which could potentially have a negative effect on health and performance (Burciaga-Robles et al., 2010) Similar to Richeson et al. (2009) morbidity due to vaccination timing did not decrease as reported in previous studies (Howard et al., 1989; Bolin and Ridpath, 1995), which were BVDV challenge studies and calves were limited to BVDV exposure unlike the current study and studies by Richeson et al. (2008, 2009).

Total and Differential WBC Count

No treatment effects were observed for vaccination or implant on total or differential WBC concentrations ($P \geq 0.76$). Total WBC count was similar for all treatments ($P \geq 0.76$), with a cubic day effect ($P = 0.01$), increasing prior to reaching a plateau at the end of the receiving period (d 42). Greater total WBC count may indicate a greater occurrence of pathogenic infection, or an increased immune response to an antigen from vaccination, allowing the animal to respond more quickly to a pathogenic infection which is the overall result and expectation of vaccination methods (Richeson et al., 2009). Percentage of lymphocytes increased linearly ($P = 0.001$), and percentage of neutrophils decreased linearly ($P \leq 0.0001$) through the end of receiving (d 42). Thus, the neutrophil:lymphocyte ratio (N:L), as an indicator of stress (McGlone et al., 1993; Gross and Siegel, 1983), decreased (linear, $P \leq 0.0001$), throughout receiving. Similar results were found by Richeson et al. (2009), reporting decreasing N:L throughout receiving to be an indicator of stress during early receiving across all treatments. Richeson et al. (2009) also found that delaying clostridial and respiratory vaccinations 14-d may have reduced stress on arrival reporting a tendency for lower N:L for delayed vaccination over the receiving period.

Percentage of eosinophils tended to increase linearly ($P = 0.11$) from d 0 to 14 and overall from d 0 to 42. Generally, circulating eosinophil numbers increase with the age of the animal until fully grown (Jain, 1993). Red blood cells were greatest on arrival and decreased (quadratic, $P = 0.002$) from d 0 throughout receiving. Increased red blood cells on arrival was likely due to dehydration from the period of marketing and transportation, and potentially contributing to stress and limiting implant efficacy. Platelets increased (quadratic, $P = 0.02$) and were greatest on d 14 prior to reaching equilibrium on d 42, similar to d 0 of the study, indicating

inflammation was greatest at d 14 of the study. Platelets tended ($P \geq 0.03$) to be greater for AVAC on d 28 than 42, greater than AVACIMP on d 42, and greater than DVACIMP on d 42. Cattle vaccinated on arrival (AVAC) tended to have greater platelet counts on d 42 than AVACIMP on d 0, DVAC, and DVACIMP on d 14. Platelets decreased (linear, $P < 0.0001$) throughout receiving in cattle vaccinated on arrival with implant (AVACIMP). All total and differential WBC counts were within normal limits for bovine blood.

In summary, there were no beneficial or detrimental effects of delaying BRD vaccination 14-d on performance or morbidity rates of high-risk, newly received stocker calves. Implanting on arrival had no effect of performance and did not affect morbidity. Cattle vaccinated on arrival had increased BVDV type 1a antibody concentrations than cattle delayed vaccination 14-d. Increase in antibody concentration continued throughout the end of the 42-d receiving period.

Table 1. Effect of bovine respiratory disease vaccination timing and hormonal growth implant on performance of newly received stocker cattle

						P-value		
Item	AVACIMP[1]	AVAC[2]	DVACIMP[3]	DVAC[4]	SEM	VACC[5]	IMP[6]	Interaction
Initial BW, kg	203	203	202	200	4.41	0.34	0.75	0.77
Final BW, kg	240	239	241	237	11.3	0.91	0.50	0.65
ADG, kg								
d 0 to 14	0.79	0.93	0.71	0.67	0.31	0.28	0.73	0.54
d 14 to 28	0.96	0.84	1.1	1.04	0.18	0.16	0.45	0.80
d 28 to 42	0.94	0.89	0.91	0.94	0.19	0.81	0.79	0.55
d 0 to 42	0.87	0.85	0.90	0.88	0.19	0.53	0.64	0.96

[1]AVACIMP = arrival (d 0) bovine respiratory disease vaccination with implant
[2]AVAC = arrival bovine respiratory disease vaccination without implant
[3]DVACIMP = delayed (d 14) bovine respiratory disease vaccination with implant
[4]DVAC = delayed bovine respiratory disease vaccination without implant
[5]VACC = main effect of bovine respiratory disease vaccination timing (d 0 vs 14)
[6] IMP = main effect of implant vs not implanting; Interaction = vaccine timing x implant strategy

Table 2. Effect of bovine respiratory disease vaccination timing and hormonal growth implant on health of newly received stocker cattle

						P-value		
Item	AVACIMP[1]	AVAC[2]	DVACIMP[3]	DVAC[4]	SEM	VACC[5]	IMP[6]	Interaction
Morbidity, %								
Pull 1	74.1	82.9	84.9	79.6	12.3	0.62	0.44	0.82
Pull 2	50.1	48.0	55.0	48.4	14.4	0.68	0.50	0.73
Pull 3	31.7	19.1	25.3	25.5	8.7	0.91	0.51	0.20
Pull 4	7.6	14.7	13.1	12.2	9.6	0.59	0.35	0.25
Day to 1st treated	0.97	1.09	0.93	1.31	0.32	0.66	0.24	0.52

[1]AVACIMP = arrival (d 0) bovine respiratory disease vaccination with implant
[2]AVAC = arrival bovine respiratory disease vaccination without implant
[3]DVACIMP = delayed (d 14) bovine respiratory disease vaccination with implant
[4]DVAC = delayed bovine respiratory disease vaccination without implant
[5]VACC = main effect of bovine respiratory disease vaccination timing (d 0 vs 14)
[6]IMP = main effect of implant vs not implanting; Interaction = vaccine timing x implant strategy

Figure 1. Effect of bovine respiratory disease vaccination timing and hormonal growth implant on BVDV Type 1a antibody concentrations of newly received stocker cattle

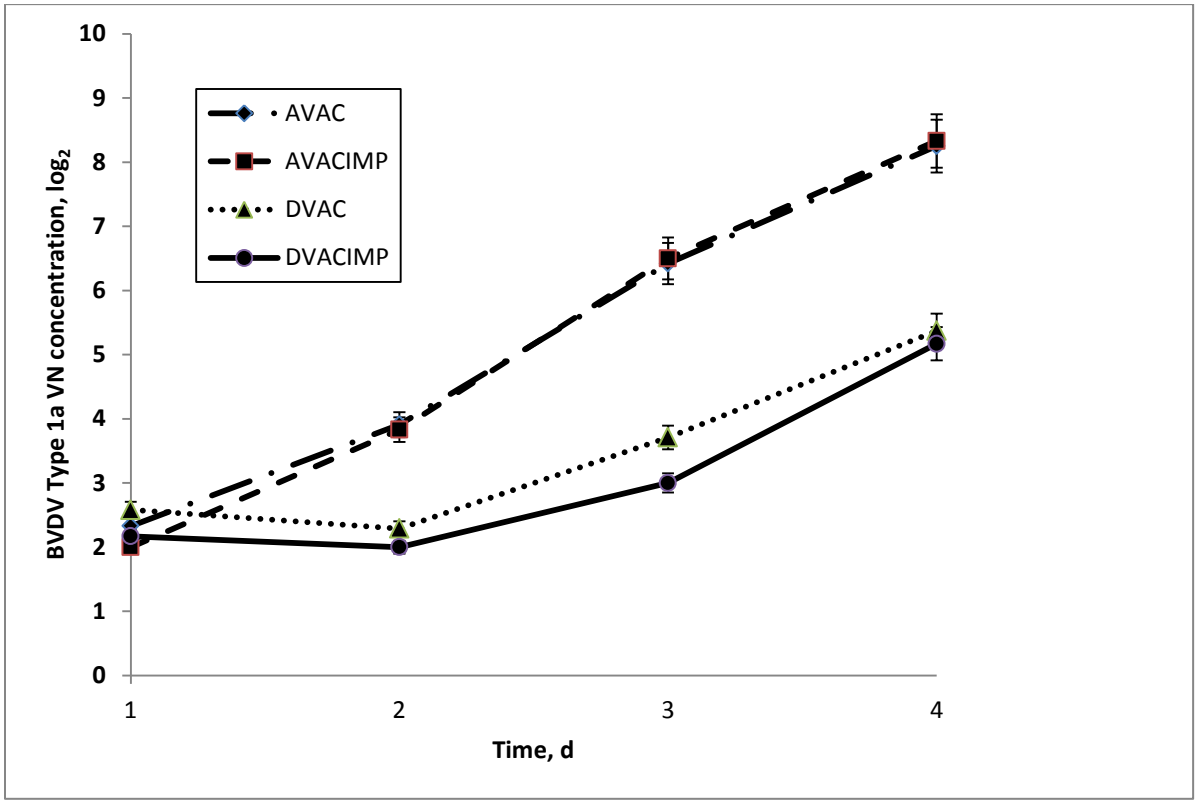

Figure 1. Effect of bovine respiratory disease vaccination timing and implant on bovine viral diarrhea virus (BVDV) type 1a antibody concentrations of newly received stocker cattle. VAC x day interaction (Cubic, $P = 0.08$). Effect of vaccine treatment x day ($P = 0.01$). No effect of IMP treatment ($P = 0.52$). AVACIMP = arrival (d 0) bovine respiratory disease (BRD) vaccination with implant; AVAC = arrival BRD vaccination without implant; DVACIMP = delayed BRD disease vaccination with implant; DVAC = delayed BRD vaccination without implant.

Table 3. Effect of bovine respiratory disease vaccination timing and hormonal growth implant on complete and differential white blood cell concentrations of newly received cattle

						P-value		
Item	D 0	D 14	D 28	D 42	SEM	Day Lin[1]	Day Quad[2]	Day Cubic[3]
White blood cells, n x 10^3/ µL	8.22	8.09	9.35	8.56	0.41	0.06	0.26	0.01
Neutrophils, %	39.8	34.6	34.0	31.8	1.8	<0.01	0.11	0.18
Lymphocytes, %	44.7	48.5	48.5	51.22	2.1	<0.01	0.65	0.23
Monocytes, %	13.6	14.8	15.3	14.7	0.92	0.06	0.06	0.84
Eosinophils, %	0.61	0.92	0.86	1.01	0.12	0.01	0.40	0.24
N:L ratio[4]	1.2	1.09	0.95	0.90	0.11	<0.0001	0.64	0.67
Monocytes, %	13.6	14.8	15.3	14.7	0.92	0.06	0.06	0.84
Red Blood Cells, n x 10^6/µL	10.5	9.35	9.46	9.69	0.22	<0.0001	<0.0001	0.002
Platelets, K/µL	6.19	6.27	6.15	6.24	0.78	0.001	0.02	0.31

[1]Day Lin = Linear effect of day
[2]Day Quad = Quadratic effect of day
[3]Day Cubic = Cubic effect of day
[4]N:L ratio = neutrophil:lymphocyte ratio

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CHAPTER IV

CONCLUSION

Results from various receiving studies are contradicting at this time. Cattle were stressed on arrival and stress was alleviated throughout receiving. In the current study there were no beneficial or detrimental effects of delaying BRD vaccination 14-d on performance or morbidity rates of high-risk, newly received stocker calves. Implanting on arrival had no effect of performance and did not affect morbidity. Cattle vaccinated on arrival had increased BVDV type 1a antibody concentrations than cattle delayed vaccination 14-d. Increase in antibody concentration continued throughout the end of the 42-d receiving period.