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Comparison of reproductive performance of primiparous dairy cattle following revaccination with either modified-live or killed multivalent viral vaccines in early lactation

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ABSTRACT

The objective of this randomized clinical trial was to compare the effect of revaccination in primiparous dairy cows with modified live viral (MLV) or killed viral (KV) vaccines containing bovine viral diarrhea virus (BVDV) and bovine herpesvirus-1 (BoHV-1) on (1) pregnancy rate following estrus synchronization-timed artificial insemination (TAI), (2) serum progesterone concentrations, and (3) serum neutralizing antibody titers at revaccination and at TAI. Primiparous dairy cows (n = 692) that had been previously vaccinated with 4 doses of MLV vaccine as calves or heifers were randomized to receive either an MLV or a KV vaccine between 21 and 28 d in milk and 17 d before initiation of a double-Ovsynch-TAI protocol. Serum was collected within the double-Ovsynch protocol for determination of progesterone concentrations, and at vaccination and TAI for serum neutralizing antibody titers. Ultrasound pregnancy determinations were made at 30 and 60 d after TAI. No differences in pregnancy rates were observed between cows receiving MLV vaccine (44%; n = 326) or KV vaccine (43%; n = 336). No differences were observed in serum progesterone concentrations during a double-Ovsynch-TAI protocol between cows receiving MLV and KV vaccines. No differences were observed in BVDV 1 or BVDV 2 antibody titers at vaccination and TAI between cows receiving MLV or KV vaccine; however, BoHV-1 antibody titers were greater at TAI in cows receiving KV vaccine. Overall response to vaccination—defined as the percent of all individual cows that had any detectable increase in antibody titer from vaccination to TAI—was 39% for BVDV 1, 45% for BVDV 2, and 61% for BoHV-1. In this research, use of an MLV vaccine did not impede reproduction when revaccination was performed between 21 and 28 DIM and just before enrollment in an estrus synchronization-TAI program in primiparous dairy cows; however, response to vaccination as defined by increases in virus-specific antibody titers could be considered less than ideal for this population of cattle.

Key words: immunity, vaccination, modified-live viral, killed viral

INTRODUCTION

Dairy herd profitability is predicated on reproductive performance because pregnancy and parturition initiate and renew lactation cycles. Reproductive efficiency of dairy herds is greatly affected by pregnancy losses due to infectious disease. Bovine viral diarrhea virus (**BVDV**) and bovine herpesvirus-1 (**BoHV-1**) are important viral pathogens of the bovine reproductive tract, resulting in infertility, abortions, and birth of calves with poor health (Walz et al., 2010; Givens et al., 2012). These pathogens and their respective diseases are present in dairy herds worldwide, thus affecting reproductive and overall efficiency of the dairy industry. Vaccination provides an important contribution to limiting reproductive losses associated with these viral infections and is an important control procedure to limit transmission of BVDV and BoHV-1 among dairy cattle populations. Modified-live viral (**MLV**) or killed viral (**KV**) vaccines are available for BVDV and BoHV-1, often in multivalent formulations. Although MLV vaccines containing BVDV and BoHV-1 are considered to provide longer immunity and greater protection against reproductive loss (Rodning et al., 2010; Givens et al., 2012), concerns have been expressed regarding the safety of these multivalent vaccines on female reproduction, with the majority of concern focused on the BoHV-1 fractions of the MLV vaccines causing abortions when given to pregnant cattle (O'Toole et al., 2012, 2014).

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An additional safety concern associated with MLV vaccines containing BVDV and BoHV-1 is infertility when MLV vaccines are administered in proximity to time of breeding (Van der Maaten and Miller, 1985; Chiang et al., 1990; Smith et al., 1990; Perry et al., 2013). Use of MLV vaccines in naïve heifers at the onset of standing estrus has been demonstrated to have negative effects on function of the corpus luteum (Van der Maaten and Miller, 1985; Smith et al., 1990). Furthermore, timing of a BoHV-1 viremia within the stage of the estrous cycle is a critical determinant of negative effects on estrous cyclicity and fertility. When BoHV-1 viremia occurs as a result of MLV vaccination during development of the corpus luteum after ovulation, severe necrotizing lesions develop (Van der Maaten et al., 1985; Miller and Van der Maaten, 1986). Severe necrotizing lesions within the corpus luteum have been associated with decreased circulating concentrations of progesterone (**P4**), prolonged interestrus intervals, and a subsequent, transient subfertility.

Efficient reproduction is important for optimal profitability on dairy cattle farms (Wiltbank et al., 2011). Many dairy farms do not attain optimal reproduction because of numerous factors related to management, health, and physiology of the lactating dairy cow. To circumvent some of the management problems, estrus synchronization programs have become standard components in the current breeding management of cows on most dairy operations (Macmillan, 2010). Many synchronization programs are based on protocols that allow timed inseminations (**TAI**) to bypass practical difficulties associated with estrus detection. Almost all programs involve strategically timed injections of $PGF_{2\alpha}$ and GnRH. While dairies are managing reproduction, attention must also be given to immunization against reproductive pathogens including BVDV and BoHV-1. Many large dairy operations utilize MLV vaccination against reproductive pathogens during the early postpartum period, and these vaccine administrations often occur within 2 to 4 wk of initiating estrus synchronization and TAI protocols. Because of the concerns associated with MLV vaccine usage on dairy cow reproductive performance, the overall goal of this study was to examine MLV vaccination in primiparous dairy cows where vaccination and initiation of an estrus synchronization-TAI program occurred in close time proximity. The null hypothesis was that MLV revaccination within 28 d of the initiation of a double-Ovsynch protocol would not result in transient subfertility and affect response to synchronization and pregnancy rate at TAI. Thus, the objective of this research was to compare the effect of revaccination in postpartum primiparous dairy cows at 21 to 28 d after calving with MLV or KV vaccination on (1) pregnancy rate, (2) serum P4 concentrations at 3 critical times during a double-Ovsynch/TAI protocol, and (3) serum neutralizing antibody titers at vaccination and at TAI.

MATERIALS AND METHODS

Animals

Six hundred ninety-two primiparous cows were used for the current study. The study was conducted on a large commercial dairy farm (3,300 lactating dairy cows) located in Saranac, Michigan, between August 2013 and February 2014. All primiparous cows were housed in freestall barns separate from multiparous cows, milked 3 times daily, provided ad libitum access to water, and fed twice daily a TMR that was balanced to meet or exceed nutrient recommendations for primiparous lactating dairy cows. All study procedures were approved by the Auburn University Animal Care and Use Committee (PRN 2013–2274) and the Auburn University Clinical Research Review Committee. All primiparous cows enrolled in this study had received 3 MLV (Express FP 10, Boehringer Ingelheim Vetmedica Inc., St. Joseph, MO) vaccinations as young calves at the farm of origin (at 5 wk of age, at 3–4 mo of age, and at 6–7 mo of age), and 1 MLV (Express FP 10, Boehringer Ingelheim Vetmedica Inc.) vaccination while at a commercial heifer breeding facility in Garden City, Kansas, at approximately 2 mo before calving. Prepartum heifers were transported from the heifer breeding facility to the dairy at approximately 2 mo before the calving date. Following calving, only primiparous cows were enrolled that did not possess any of the following exclusion criteria: (a) BCS of 1 or 5, (b) history of retained fetal membranes, (c) treatment for uterine infections within the first 14 DIM, or (d) surgical correction of a displaced abomasum within first 14 DIM. Lists of eligible cows between 14 and 21 DIM were sent electronically every week to Auburn University for randomization to study group and for blood sampling. Enrollment dates for study cows occurred from June 24, 2013, to January 28, 2014. Eligible cows were randomly assigned to group A or group B using random number generator function of commercially available software (Excel, Microsoft Corp., Redmond, WA). Random numbers were generated for each cow and sorted from low to high. For each enrollment date, the lowest half of random numbers were assigned to group A and the highest half of random numbers were assigned to group B. Once cows were assigned to a treatment group, the random number generator function was again used to generate the subset of cows within each group for blood sampling at vaccination and during the estrus synchronization-TAI program. Equal numbers of