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Effects of weekly regrouping of prepartum dairy cows on innate immune response and antibody concentration

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ABSTRACT

Objectives were to evaluate the effects of a stable prepartum grouping strategy on innate immune parameters, antibody concentration, and cortisol and haptoglobin concentrations of Jersey cows. Cows (253 ± 3 d of gestation) were paired by gestation length and assigned randomly to the stable (all-in-all-out; AIAO) or traditional (TRD) treatment. In the AIAO treatment, groups of 44 cows were moved into a pen where they remained for 5 wk, whereas in the TRD treatment, approximately 10 cows were moved into a pen weekly to maintain stocking density (44 cows for 48 headlocks). Pens were identical in size and design and each pen received each treatment a total of 3 times (6 replicates; AIAO, n = 259; TRD, n = 308). A subgroup of cows (n = 34/treatment) was selected on wk 1 of each replicate from which blood was sampled weekly from d −14 to 14 (d 0 = calving) to determine polymorphonuclear leukocyte (PMNL) phagocytosis, oxidative burst, and expression of CD18 and L-selectin, hemogram, cortisol and glucose concentrations, and haptoglobin concentration. Another subgroup of cows (n = 40/treatment) selected on wk 1 of each replicate was treated with chicken egg ovalbumin on d −21, −7, and 7 and had blood sampled weekly from d −21 to 21 for determination of immunoglobulin G anti-ovalbumin. All cows (n = 149) had blood sampled weekly for nonesterified fatty acid (NEFA) and β-hydroxybutyrate (BHBA) concentrations from d −21 to 21. Treatment did not affect percentage of PMNL positive for phagocytosis and oxidative burst (AIAO = 64.3 ± 2.9 vs. TRD = 64.3 ± 2.9%) and intensity of phagocytosis [AIAO = 2,910.82 ± 405.99 vs. TRD = 2,981.52 ± 406.87 geometric mean fluorescence intensity (GMFI)] and oxidative burst (AIAO = 7,667.99 ± 678.29 vs. TRD = 7,742.70 ± 682.91 GMFI). Similarly, treatment did not affect the percentage of PMNL expressing CD18 (AIAO = 96.3 ± 0.7 vs. TRD = 97.8 ± 0.7%) and L-selectin (AIAO = 44.1 ± 2.8 vs. TRD = 45.1 ± 2.8%) or the intensity of expression of CD18 (AIAO = 3,496.2 ± 396.5 vs. TRD = 3,598.5 ± 396.9 GMFI) and L-selectin (AIAO = 949.8 ± 22.0 vs. TRD = 940.4 ± 22.3 GMFI). Concentration of immunoglobulin G anti-ovalbumin was not affected by treatment (AIAO = 0.98 ± 0.05 vs. TRD = 0.98 ± 0.05 OD). The percentage of leukocytes classified as granulocyte (AIAO = 38.9 ± 1.5 vs. TRD 38.2 ± 1.5%) and the granulocyte:lymphocyte ratio (AIAO = 0.75 ± 0.04 vs. TRD = 0.75 ± 0.04) were not affected by treatment. Concentrations of cortisol (AIAO = 14.95 ± 1.73 vs. TRD = 18.07 ± 1.73 ng/mL), glucose (AIAO = 57.6 ± 1.5 vs. TRD = 60.0 ± 1.5 ng/mL), and haptoglobin (AIAO = 3.09 ± 0.48 vs. TRD = 3.51 ± 0.49 OD) were not affected by treatment. According to the current experiment, a stable prepartum grouping strategy does not improve innate immune parameters or antibody concentration compared with weekly prepartum regrouping.
Key words: dairy cow, regrouping, immune response

INTRODUCTION

Stressors elicit biological responses that are behavioral, neuroendocrine, autonomic, and immune in nature (Moberg, 2000). Several conditions (i.e., elevated temperature humidity index, excessive regrouping, high stocking density) to which prepartum cows are exposed are considered stressors and believed to have profound consequences to health and productive parameters because of their effects on immune, neuroendocrine, and behavioral responses. von Keyserlingk et al. (2008) demonstrated that within the first few hours and days after regrouping, lactating dairy cows that were moved to a new pen had reduced resting time, reduced feed

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intake, and greater rate of displacement from the feed bunk. Accompanied by these behavioral changes, cows that were moved to a different pen had reduced milk yield on the day after regrouping (von Keyserlingk et al., 2008). Stress and pain associated with castration and dehorning cause neutrophilia, reduced secretion of tumor necrosis factor-α by PMNL, and reduced PMNL oxidative burst intensity (Ting et al., 2003; Doherty et al., 2007; Ballou et al., 2013), whereas stress associated with weaning and transport causes a reduction in circulating concentrations of immunoglobulin in pigs (Kojima et al., 2008). The peripartum period is the most delicate phase of a cow's life because of important nutrient balance, hormonal, and immune changes associated with lactogenesis and parturition. Therefore, it has been suggested that prepartum cows subjected to regrouping could suffer more severe negative energy balance and immunosuppression as a consequence of either decreased feed intake or increased concentration of cortisol. Cook and Nordlund (2004) have suggested that, to eliminate stress related to reorganization of social order following regrouping, cows should be moved in groups to a prepartum pen and no new cows should enter these prepartum pens until all cows have calved. This is a similar concept to the all-in-all-out (**AIAO**) system that is commonly used in other food animal-producing systems (i.e., poultry and swine) to minimize the transmission of infectious diseases.

Reduced feed intake during the periparturient period is associated with increased concentrations of NEFA and BHBA, which have been associated with reduced myeloperoxidase activity of PMNL (Hammon et al., 2006). Furthermore, PMNL of cows diagnosed with metritis have reduced myeloperoxidase activity in the week of parturition (Hammon et al., 2006). On the other hand, exposure to stressors results in increased cortisol concentrations, which may affect concentrations of IgG and IgM (Mallard et al., 1997; Lacetera et al., 2005). Consequently, identifying management strategies that may affect DMI and concentrations of NEFA and BHBA and cause stress is important to reduce immunosuppression during the periparturient period.

The hypotheses of the current experiment were that a prepartum grouping strategy that reduces agonistic behavior (AIAO vs. weekly entry of new cows) would result in reduced cortisol concentration, improved PMNL activity (phagocytosis and oxidative burst), increased expression of adhesion molecules by PMNL (L-selectin and β2-integrins), increased IgG concentration in response to an ovalbumin challenge, and increased IgG concentration in colostrum. Therefore, the objectives of the current experiment were to evaluate if a stable prepartum grouping strategy (AIAO) would reduce concentrations of cortisol and improve innate immune parameters and antibody concentration during the peripartum compared with a traditional prepartum grouping strategy in which new cows are introduced weekly into the prepartum pen.

MATERIALS AND METHODS

Cows used in the current experiment are a subgroup of cows used in a larger experiment (Silva et al., 2013). Detailed description regarding facilities, management, and nutrition may be found in Silva et al. (2013). Briefly, the experiment was conducted from February 2011 to October 2012 in a dairy located in southern Minnesota. Throughout the experiment, Jersey cows were housed in cross-ventilated freestall barns. During the prepartum period (d −28 to 0; d 0 = calving), cows were housed in 1 of 2 freestall pens with 44 stalls and 48 headlocks that were identical in size and design. At the start of each replicate, the target stocking density was 100% of stalls and 91.6% of headlocks. From calving to d 21, all cows were housed in the same freestall pen with 240 stalls and 260 headlocks, and stocking density did not exceed 100 and 91.6% of stalls and headlocks, respectively. From d 21 until diagnosis of pregnancy 66 ± 3 d after AI, cows were housed in freestall barns with 240 stalls and 260 headlocks, and stocking density varied between 110 and 120% of headlocks and between 119% and 130% of stalls. Artificial lighting was provided during the prepartum (8 h of light and 16 h of dark) and postpartum (16 h of light and 8 h of dark) periods. All cows received the same TMR during the prepartum period, from calving to d 21, and after d 21. Diet compositions are described in Silva et al. (2013).

Treatments

Prepartum Jersey cows (≥ first lactation) were enrolled in the experiment at 253 ± 3 d of gestation. At enrollment, cows were balanced for parity (first or ≥ second lactation) and projected 305-d mature-equivalent milk yield and were sequentially assigned to 1 of the 2 study pens. Treatment applied to the study pens in the first replicate was determined randomly (coin toss). Cows assigned to the AIAO (n = 6 replicates with a total of 259 cows) grouping strategy were moved to the prepartum pen in groups of 44 cows (stocking density of 100% of stalls and 91.6% of headlocks), but no new cows were added to the AIAO pen until the end of the replicate. Cows assigned to the traditional (**TRD**, n = 6 replicates with a total of 308 cows) grouping strategy were moved to the prepartum pen as a group of 44 cows. Weekly thereafter, groups of 2 to 15 cows (median = 9 cows) were moved to the TRD pen to re-establish the desired stocking density (100% of stalls and 91.6% of