J. Dairy Sci. 97:1–15
http://dx.doi.org/10.3168/jds.2013-7154

Potential risk indicators of retained placenta and other diseases in multiparous cows

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ABSTRACT

Retained placenta (RP), defined as fetal membranes not being expelled within 24 h after calving, is a costly disease in multiparous dairy cows that has been linked to immune suppression, infections, elevated lipid mobilization, and depleted status of antioxidants including α-tocopherol, and that increases the risk of other diseases (OD) in early lactation. Early detection of cows at increased risk of developing RP, OD, or both in early lactation could improve treatment success and result in improved milk production and reproductive performance. To identify risk indicators of RP, OD, or both, we used a nested case-control design and compared multiparous dairy cows that developed RP (n = 32) with cows that remained healthy (H; n = 32) or cows that developed OD (n = 32) in early lactation. We compared peripartal body condition score (BCS) as well as serum concentrations of α-tocopherol, metabolites [β-hydroxybutyrate (BHBA), cholesterol, glucose, nonesterified fatty acids (NEFA), and urea N], haptoglobin, and macrominerals (i.e., calcium, magnesium, and phosphorus) on d −21, −14, −7, −3, −1, 0, 1, 3, 7, 14, 21, 28, 35, 42, and 49 postpartum. In addition, average serum concentrations were calculated for each cow for the last 3 wk prepartum, for 3 and 2 wk prepartum combined, for the last week prepartum, and for the morning after calving and compared between groups. The RP cows had lower BCS than the H or OD cows until 2 wk postpartum. During the prepartal periods, RP and OD cows had lower α-tocopherol concentrations (corrected or not for cholesterol concentration) and higher NEFA and BHBA concentrations than H cows. Thus, lower prepartal BCS could be an early predictor for RP risk, and lower α-tocopherol concentrations and higher NEFA and BHBA concentrations could be early predictors for disease.

Key words: α-tocopherol, biomarker, dairy cow, disease, retained placenta

INTRODUCTION

Normal expulsion of fetal membranes occurs within 8 h after calf delivery. Retained placenta (**RP**) is defined as failure to expel fetal membranes within 24 h (Kelton et al., 1998). Retained placenta is an economically important disease that affects approximately 7.8% (range: 1.3 to 39.2%) of US dairy cows (Kelton et al., 1998; USDA, 2009). The average cost of RP, including treatment costs, milk loss, and increased days open, is estimated to be $285 per case (Kelton et al., 1998). Additional RP-associated costs that are not included in the cost estimate are increased culling rates and increased incidence of other diseases (**OD**), as RP is an established risk factor for metritis and ketosis (Curtis et al., 1985; Markusfeld, 1987; Laven and Peters, 1996). The primary risk factors associated with RP are premature births, multiple calves, dystocia, abortion, stillbirths, uterine infections, age of cow, milk fever, antioxidant (e.g., selenium, α-tocopherol, and β-carotene) deficiency, and calving season (reviewed in Laven and Peters, 1996; Drillich, 2011).

Multiple physical, endocrine, and cellular factors are involved in the expulsion of fetal membranes. Several causes for RP have been proposed in recent years: (1) uterine atony (<2% of cases); (2) edema of the chorionic villi as a consequence of physical damage associated with birthing complications, caesarian section, or twisted uterus; (3) cellular dysfunction and necrosis related to uterine infections; (4) incomplete breakdown of extracellular matrix by collagenase and matrix metalloproteinases related to steroid hormone imbalances; (5) decreased innate and humoral immune responses; and (6) oxidative damage associated with insufficient antioxidants (McNaughton and Murray, 2009; Drillich, 2011).

Given the economic losses associated with RP and OD in early lactation (Kelton et al., 1998), early detection of cows at increased risk of developing RP, OD, or

Received January 18, 2013.
Accepted March 16, 2014.
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both could improve treatment success and result in improved milk production and reproductive performance. To date, circulating NEFA concentrations >300 to 500 μEq/L have been reported as an early indicator of RP in large, multi-herd field trials in the last week prepartum (LeBlanc et al., 2004; Ospina et al., 2010; Chapinal et al., 2011). Elevated NEFA concentrations in the last week prepartum, however, are also a risk indicator for OD in early lactation (Ospina et al., 2010; Moyes et al., 2013). Furthermore, risk indicators detected in the last week precalving leave little time for RP or OD prevention. Using data from a large vitamin E supplementation trial in the Guelph, Canada, area (LeBlanc et al., 2002), LeBlanc et al. (2004) showed that cows that developed RP had, in the last week prepartum, lower serum α-tocopherol concentrations than cows that did not develop RP. Although inflammation and macromineral status have been implicated in the development of RP, the association between serum markers of inflammation (e.g., haptoglobin) and macromineral status (i.e., calcium, magnesium, and phosphorus) prepartum and RP has not to our knowledge been reported. The exception is calcium; in large, multi-herd field trials during the last week precalving, calcium concentrations and RP incidence were not associated (Quiroz-Rocha et al., 2009; Chapinal et al., 2011).

We hypothesized that BCS and serum concentrations of markers of antioxidant status (α-tocopherol), lipid transport (cholesterol), energy and nitrogen balance (i.e., BHBA, glucose, NEFA, and urea N), inflammation (haptoglobin), and macromineral status (i.e., calcium, magnesium, and phosphorus) are altered before and after RP as well as OD. The objective of this study was to compare during the peripartal period (−3 to 7 wk postpartum) BCS and serum concentrations of these various markers between multiparous dairy cows that developed RP, OD (i.e., metritis, mastitis, ketosis, or laminitis), or remained healthy in early lactation.

MATERIALS AND METHODS

Animals and Study Design

All procedures involving animals were approved by the Oregon State University Institutional Animal Care and Use committee. The research was conducted on a 1,000-head commercial dairy farm in Oregon's Central Willamette Valley during spring and summer 2010. We only collected blood samples and monitored the health of purebred pregnant Holstein cows that had completed ≥1 lactation, were free of diseases, and had a BCS of ≥3.0 at the start of the study. The cohort consisted of 161 multiparous Holstein cows (upcoming parity 2 to 7). Using a nested case-control design, we identified cows that developed RP (n = 32), developed OD (n = 32; i.e., metritis, mastitis, ketosis, or laminitis), or remained healthy (**H**; n = 32) during the first 28 d after calving. Cows were matched based on parity and calving season.

Starting 28 d before predicted calving date, BCS of cows were scored 1×/wk by 3 trained, independent evaluators until 4 wk postpartum and then at wk 7 and 14 postpartum (Edmonson et al., 1989). During the last 4 wk before expected calving, cows were housed in a straw-bedded freestall barn and were fed once in the morning (0730 h) a TMR based on corn, corn silage, and alfalfa and triticale hay, which met NRC (2001) guidelines and contained vitamin E at 167 IU/kg of DM as *all-rac*-α-tocopheryl acetate (Table 1). After calving, healthy cows stayed the first 2 d in the hospital pen, and then for 4 wk in the early lactation pen, and then for wk 5 to 17 postpartum based on body size (largest, medium, and smallest based on height and depth of cows) in 3 mid-lactation pens. Cows diagnosed with diseases were moved back to the hospital pen for treatment. Cows were fed around 0800 and 1330 h a TMR based on corn, corn silage, and alfalfa hay, which met NRC (2001) guidelines and contained vitamin E at 24.5 IU/kg of DM as *all-rac*-α-tocopheryl acetate (Table 1).

Animal Health Surveillance and Disease Treatment

During the study period, cows were monitored daily for abnormal milk, gait, appetite, general appearance, alertness, vaginal discharge, and RP. Uterine discharge and milk SCC were checked 2×/wk. Urinary ketones and body temperature were checked if a cow appeared not healthy, which included depressed feed intake, lethargy, cold ears, and rapid BCS loss. Diseases were diagnosed and treated based on standard operating procedures developed by the Oregon State University veterinary staff and were consistent with standard of care veterinary practices. Diagnosis and treatment of diseases was done by the herd manager, who was trained and supervised by the Oregon State University veterinarian. The veterinarian visited at least 1×/wk to supervise diagnosis and treatment of diseases.

Retained placenta was diagnosed as failure to expel fetal membranes within 24 h after parturition. Cows with RP remained in the hospital pen and were infused with 57 g of tetracycline HCl powder (714 g of tetracycline/kg; IVX Animal Health Inc., St. Joseph, MO) in 1 L of water every 4 to 8 d until the placenta was expelled. To prevent infections, cows were injected i.m. for up to 7 d with penicillin (40 mL/d, Penicillin G Procaine; Aspen Veterinary Resources Ltd., Liberty, MO), followed by treatment for up to 7 d with sulfadimethoxine (30 g/d, Sulfasol soluble powder, Med-Pharmex, Pomona, CA).