J. Dairy Sci. 97:7844–7855
http://dx.doi.org/10.3168/jds.2014-8465

Associations of serum haptoglobin in newborn dairy calves with health, growth, and mortality up to 4 months of age

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ABSTRACT

The objective of this research was to investigate factors associated with serum haptoglobin (Hp) levels in newborn calves. In addition, the associations between serum Hp levels in newborn calves with growth, morbidity, and mortality in calves <4 mo of age were investigated. A total of 1,365 Holstein heifer calves from 15 dairy farms were enrolled in this study from January to December, 2008. Following calving, a birth record was completed, including information on the calving event, colostrum administration, and other details. During weekly farm visits, each calf was assessed at 1 to 8 d, 15 to 21 d, 36 to 42 d, and 90 to 120 d of age. At these sampling times, each calf was assessed using a standardized clinical score for general health, and height and weight were measured. At 1 to 8 d of age, a blood sample was collected to measure serum total protein and Hp concentrations. Treatment events and death loss were recorded throughout the study by the farm staff. Serum Hp concentration in the first week of life was not significantly associated with the degree of calving difficulty. However, serum Hp was higher in calves with a higher rectal temperature and depressed attitude at the first sampling time. Furthermore, the association between serum Hp and the severity of nasal discharge varied by age at first sampling time. Calves with higher Hp in their first week of life had significantly higher total health scores throughout the entire sampling period. Haptoglobin was not significantly associated with average daily gain or treatment for bovine respiratory disease. Yet, for every 1 g/L increase in serum Hp in the first week of life, the odds of being treated for any other disease during the study period increased by 7.6 times. Treatment for bovine respiratory disease, diarrhea, or any other disease resulted in increased odds of calf mortality. In addition, Hp concentration in the first week of life was associated with mortality in calves <4 mo of age. The optimal cut point for Hp was determined to be 0.13 g/L for the prediction of disease and death, although the sensitivity of Hp concentration alone as a diagnostic test for individual calves was low.
Key words: haptoglobin, calving difficulty, health, mortality

INTRODUCTION

Infectious diseases are a serious issue on commercial dairy farms, and can lead to substantial economic loss and animal welfare concerns. Tools for the diagnosis and surveillance of disease are needed to prevent these losses (LeBlanc et al., 2006).

Blood biochemical and hematological values are gaining broader attention for their potential role in disease diagnosis and as a measurement of general health. Specifically, acute-phase proteins produced in response to a bacterial or viral challenge can be used as quantitative indicators of infection, inflammation, tissue injury, or stress (Murata et al., 2004; Petersen et al., 2004). One of the major acute-phase proteins in the bovine is haptoglobin (**Hp**), which reduces prooxidative and proinflammatory stress through binding hemoglobin and removing it from circulation (Murata et al., 2004; Petersen et al., 2004). In addition, it has been shown that Hp has higher sensitivity in detecting disease compared with other acute-phase proteins, due to its more pronounced and prolonged response to infection (Angen et al., 2009).

In calves, disease has been associated with significant increases in serum Hp concentration (Heegaard et al., 2000; Gånheim et al. 2007; Angen et al., 2009), which can increase over 100 fold upon immune stimulation (Conner et al., 1988, 1989). Thus, researchers have suggested that serum Hp concentrations could be used to assess inflammation and disease status in calves (Carter et al., 2002; Angen et al., 2009). Combining serum Hp with rectal temperature may be a valuable parameter for herd-level diagnostics in heifer calves (Svensson et al., 2007)

Few research studies exist that have investigated the effects of difficulty at parturition on Hp levels in newborn calves. Yet, it is logical to assume that serum Hp levels would increase in newborn calves following

Received June 9, 2014.
Accepted August 14, 2014.
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a difficult calving when excessive force during extraction causes fetal stress and trauma (Haughey, 1975; Schuijt, 1990). Some reports have shown that neonatal Hp levels are high following birth (Knowles et al., 2000; Orro et al., 2008), but did not investigate the effect of calving difficulty on Hp concentrations. It has also been suggested that a difficult birth can increase the risk of morbidity and mortality later in life (Schuijt and Taverne, 1994; Lombard et al., 2007). Thus, if Hp concentration increases in association with calving difficulty, it is possible that it could be used as a biomarker for increased risk of morbidity and mortality.

The objective of this research was to investigate factors associated with serum Hp levels in newborn calves. In addition, the associations between newborn serum Hp levels with future growth, morbidity, and mortality in calves <4 mo of age were investigated.

MATERIALS AND METHODS

Study Farms and Animals

Newborn heifer calves from 15 commercial dairy farms in southwestern Ontario were enrolled in this study. Farms were selected with the assistance of local dairy practitioners and were included in the study based on criteria of farm accessibility (within 250 km of the University of Guelph in Guelph, ON, Canada) and reliable record keeping. Participating farms were not requested to change any aspects of their calf management for this study. All heifer calves born on the farms during the sampling period were included in the study. The Animal Care Committee at the University of Guelph approved the study.

Study Enrollment and Sampling

During the period from January to December 2008, heifer calves were enrolled between 1 and 8 d of age. Calves were uniquely identified with National Livestock Identification for Dairy tags (Brantord, ON, Canada) at each farm.

Producers were requested to complete a birth record for each heifer calf using forms that were provided. The birth record detailed information about the delivery circumstances, calving environment, colostrum practices, and perinatal treatments for each calf.

Farms were visited weekly by research technicians. At first sampling (1 to 8 d), a blood sample was collected by jugular venipuncture from each calf. Using a 20-gauge, 2.5-cm hypodermic needle, 10 mL of blood was drawn into a sterile glass serum collection tube without anticoagulant (BD Vacutainer; Becton, Dickinson and Co., Franklin Lakes, NJ). The blood samples were stored in coolers with an ice pack and transported to the laboratory for processing.

Calves were examined at 4 sampling times: 1 to 8 d, 15 to 21 d, 35 to 42 d, and 90 to 120 d of age. Height, weight, and rectal temperature were measured and a health score was assigned. Height was measured at the withers with the head in a neutral position. Weight was measured using a heart-girth measuring tape pulled snuggly around the thorax, just caudal to the forelimb (calves up to 5 wk: Dairy Calf Tape, and calves between 90 to 120 d: Weight-By-Breed Dairy Cow Tape; The Coburn Co. Inc., Whitewater, WI). Rectal temperature was determined using a digital thermometer (Omron Healthcare Inc., Burlington, ON, Canada). Health scores for attitude, ear position, nasal discharge, and fecal consistency using a scoring system adapted from the Calf Health Scoring Criteria previously published by the University of Wisconsin (Madison) were measured (McGuirk, 2008). Five-point scales were used for attitude and ear position, and 4-point scales were used for nasal discharge and fecal consistency. Descriptions and photographs for each score were provided to the research technicians and participating farms as a means of standardizing these assessments.

During the monitoring phase from enrollment to 90 to 120 d of age, farmers were requested to record all treatments and mortality in heifer calves using the forms supplied. For every treatment administered, the producer recorded the date, suspected disease using a standardized case definition (Windeyer et al., 2014), rectal temperature, and treatment given. To be included, the treatments must have been given because of suspected illness, not as a preventative measure. Treatments with a long-acting antibiotic had to be more than 7 d apart to be considered as new treatment events. For any other medications, treatments had to be more than 3 d apart to be considered as separate treatment events.

A farm-level questionnaire was administered to record general information about the farm operation and protocols, including details of the barn facilities and capacity, maternity areas, calf housing, calf feeding equipment, vaccination, deworming, dehorning, calving procedures, and weaning protocols.

Blood Analysis

Blood samples were centrifuged at 970 × *g* for 10 min at approximately 20°C within 24 h of collection. Serum was separated and used to assess serum total protein (**STP**) concentration by digital refractometry (range: 1–12g/dL; accuracy: ±0.1; model 300027; Sper Scientific Ltd., Scottsdale, AZ). Aliquots of serum were stored at −20°C and subsequently analyzed for