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Preweaned heifer management on US dairy operations: Part II. Factors associated with colostrum quality and passive transfer status of dairy heifer calves

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ABSTRACT

Passive transfer of immunity is essential for the short- and long-term health of dairy calves. The objective of this study was to evaluate factors associated with colostrum quality and passive transfer status of US heifer calves. This study included 104 operations in 13 states that participated in the calf component of the National Animal Health Monitoring System's Dairy 2014 study. This 18-mo longitudinal study included 1,972 Holstein heifer calves from birth to weaning. Multivariable mixed linear regression models were selected using backward elimination model selection after univariate screening to determine which factors were associated with colostrum IgG and serum IgG concentrations. The mean colostrum IgG concentration was 74.4 g/L with 77.4% of colostrum samples having IgG concentrations >50 g/L. The final model for colostrum IgG included colostrum source and a categorized temperature-humidity index value (cTHI) for the month before calving. Mean colostrum IgG concentrations were highest for dams in third and higher lactations (84.7 g/L) and lowest for commercial colostrum replacers (40.3 g/L). Colostrum IgG concentrations were highest for cTHI ≥70 (72.6 g/L) and lowest for cTHI <40 (64.2 g/L). The mean serum IgG concentration was 21.6 g/L, with 73.3% of calves having serum IgG concentrations >15 g/L. The final model for serum IgG concentration included region, heat treatment of colostrum, colostrum source, timing to first feeding, volume of colostrum fed in the first 24 h, age of the calf at blood sampling, and colostrum IgG concentration. Mean serum IgG concentrations were highest for calves that received colostrum from first-lactation dams (25.7 g/L) and lowest for calves fed commercial colostrum replacer (16.6 g/L). Serum IgG concentrations were higher for calves fed heat-treated colostrum (24.4 g/L) than for calves fed untreated colostrum (20.5 g/L). Serum IgG concentration was positively associated with the volume of colostrum fed in the first 24 h and colostrum IgG concentration, and negatively associated with the number of hours from birth to colostrum feeding and age (days) at blood collection. Dairy producers should be encouraged to measure the quality of colostrum before administering it to calves and to measure serum IgG or a proxy such as serum total protein or Brix to evaluate passive immunity and colostrum management programs.
Key words: colostrum quality, passive transfer status, dairy heifer calves

INTRODUCTION

Passive transfer of immunity via colostrum is essential for the short- and long-term health of dairy calves. Researchers have understood the importance of colostrum for prevention of disease in neonatal ruminants for over 100 yr (Famulener, 1912), yet 19.2% of calves in the United States still had failure of passive transfer (**FPT**) in 2007, with a serum IgG <10 g/L (Beam et al., 2009). Consumption and absorption of maternal immunoglobulins via colostrum are critical for reducing disease and mortality in calves in the first weeks of life, because calves are essentially agammaglobulinemic at birth (Gulliksen et al., 2008). The primary components of colostrum that contribute to passive immunity are

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immunoglobulins, which include IgG, IgA, and IgM; IgG comprises about 85% of the immunoglobulin in colostrum (Larson et al., 1980). Relative to IgG content, high-quality colostrum is defined as having an IgG concentration >50 g/L (McGuirk and Collins, 2004). In addition to water, colostrum contains important nutrients, such as protein, vitamins, minerals, and fat, which provides neonatal calves with supplemental heat energy. Factors previously associated with colostrum quality include parity (Zarcula et al., 2010), breed (Zarcula et al., 2010), and season of calving (Gulliksen et al., 2008; Ontsouka et al., 2003). Colostrum quality, which varies significantly among cows, affects passive transfer and warrants an updated evaluation.

In addition to the quality of colostrum fed, 3 important factors related to managing colostrum for adequate passive transfer should be considered: the quantity of colostrum fed, the timing of feeding, and the cleanliness of the colostrum (McGuirk and Collins, 2004). In regards to the amount of colostrum fed, the general recommendation is to feed at least 10% of BW of colostrum at the first feeding—about 4 L for the average size calf (Godden, 2008). Regarding the timing of the first colostrum feeding, calves should be fed their first colostrum as soon as possible, because the rate of immunoglobulin absorption decreases rapidly after 4 h following birth (Stott et al., 1979). Calves are only able to absorb large molecules, including immunoglobulins, during a brief period of 12 to 24 h following birth (Michanek et al., 1989). The cleanliness of the colostrum fed is crucial, as colostrum contaminated with bacteria can lead to decreased absorption of immunoglobulins due to competition at the intestinal epithelium (Stewart et al., 2005; Johnson et al., 2007).

A colostrum management program can be evaluated by measuring serum IgG or total protein concentrations in calves within the first week of life. If calves have a serum IgG concentration <10 g/L between 24 and 48 h following birth, they are considered to have FPT (Gay, 1983). Although 10 g/L is considered the cutoff value for FPT, studies have shown that calves with serum IgG concentrations >15 g/L are better able to resist respiratory infections (Furman-Fratczak et al., 2011). Other studies have recommended using 20 g/L as the cutoff value (Chigerwe et al., 2015). Failure of passive transfer increases calf morbidity and mortality and decreases calf growth (Nocek et al., 1984; Robison et al., 1988; Wells et al., 1996; Furman-Fratczak et al., 2011). Failure of passive transfer can also decrease productivity, including decreased rate of gain, decreased first- and second-lactation milk production, and increased culling rate during the first lactation (DeNise et al., 1989; Faber et al., 2005). Because of the serious consequences associated with FPT, colostrum management has been and should continue to be a focus of producer education programs (BAMN, 2001).

We believe this study will provide additional evidence to support current best practices for colostrum management, such as quality of colostrum and timing and amount of colostrum administration but will also identify other factors and practices that may lead to improved passive transfer status in dairy heifer calves. The objective of this study was to determine management practices and environmental factors associated with colostrum quality and passive transfer status of Holstein dairy heifer calves.

MATERIALS AND METHODS

Study Design

The USDA's National Animal Health Monitoring System (**NAHMS**) conducts national surveys to collect information on the health, management, and productivity of domestic livestock species (USDA, 2016). In 2014, a nationwide survey was conducted to collect information about the US dairy industry, including an 18-mo longitudinal dairy heifer calf study. All participation in NAHMS studies is voluntary. However, to participate in the longitudinal calf study, operations had to have completed both NAHMS Dairy 2014 surveys, and agreed to provide information on enrolled calves, whether raised onsite or offsite.

The calf component was part of the NAHMS Dairy 2014 study, and consisted of a convenience sample of 104 dairy operations, including both conventional and organic operations. These operations were located in 13 states, including California, Colorado, and Washington in the western region, and Iowa, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Vermont, Virginia, and Wisconsin in the eastern region. Dairy operations were categorized based on the number of mature cows, as small (30 to 99 cows), medium-sized (100 to 499 cows), and large (500 or more cows).

Data collection for the calf component of the study occurred from March 2014 to September 2015. Data collectors were trained on data and sample collection. Each operation was initially instructed to enroll 24 heifer calves over a 1-yr period, or an average of 2 calves per month. Farm personnel selected which calves to enroll in the study. However, a calf must have been alive at 24 h of age to be enrolled. Because fewer operations participated than originally planned, the number of calves that could be enrolled per operation was increased to a range of 48 to 60. Additionally, because enrollment of farms did not occur as quickly as had