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Benchmarking passive transfer of immunity and growth in dairy calves

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ABSTRACT

Poor health and growth in young dairy calves can have lasting effects on their development and future production. This study benchmarked calf-rearing outcomes in a cohort of Canadian dairy farms, reported these findings back to producers and their veterinarians, and documented the results. A total of 18 Holstein dairy farms were recruited, all in British Columbia. Blood samples were collected from calves aged 1 to 7 d. We estimated serum total protein levels using digital refractometry, and failure of passive transfer (FPT) was defined as values below 5.2 g/dL. We estimated average daily gain (ADG) for preweaned heifers (1 to 70 d old) using heart-girth tape measurements, and analyzed early (≤35 d) and late (>35 d) growth separately. At first assessment, the average farm FPT rate was 16%. Overall, ADG was 0.68 kg/d, with early and late growth rates of 0.51 and 0.90 kg/d, respectively. Following delivery of the benchmark reports, all participants volunteered to undergo a second assessment. The majority (83%) made at least 1 change in their colostrum-management or milk-feeding practices, including increased colostrum at first feeding, reduced time to first colostrum, and increased initial and maximum daily milk allowances. The farms that made these changes experienced improved outcomes. On the 11 farms that made changes to improve colostrum feeding, the rate of FPT declined from 21 ± 10% before benchmarking to 11 ± 10% after making the changes. On the 10 farms that made changes to improve calf growth, ADG improved from 0.66 ± 0.09 kg/d before benchmarking to 0.72 ± 0.08 kg/d after making the management changes. Increases in ADG were greatest in the early milk-feeding period, averaging 0.13 kg/d higher than pre-benchmarking values for calves ≤35 d of age. Benchmarking specific outcomes associated with calf rearing can motivate producer engagement in calf care, leading to improved outcomes for calves on farms that apply relevant management changes.

Key words: behavioral change, growth curve, passive immunity, morbidity

INTRODUCTION

Colostrum management is one of the most critical areas of calf care (Beam et al., 2009; Vogels et al., 2013). Calves rely on early consumption of colostrum to acquire immunoglobulins (McGrath et al., 2016). Colostrum quality depends on several factors, including the volume produced, the time of collection, the concentration of immunoglobulins, and bacteria levels (McGuirk and Collins, 2004; Godden, 2008). For successful passive transfer of immunoglobulins, of which 90% are IgG (Larson et al., 1980), the calf must ingest the colostrum soon after birth (Weaver et al., 2000). Failure of passive transfer (**FPT**) is defined as a serum IgG concentration below 10 mg/mL (Faber et al., 2005; Beam et al., 2009). Negative outcomes associated with FPT include increased preweaning morbidity (Donovan et al., 1998) and mortality (Robison et al., 1988), increased duration of illness (Paré et al., 1993), increased contagiousness or pathogen shedding (Lopez et al., 1988), reduced growth (Dewell et al., 2006), reduced milk production in the first lactation, and increased culling rates (DeNise et al., 1989).

Although the importance of passive transfer has been studied extensively, dairy farms continue to struggle with FPT and its associated economic and welfare costs. For example, surveys have found FPT rates of 25 to 37% in Canada (Wallace et al., 2006; Trotz-Williams et al., 2008), 21% in the United States (USDA, 2010), and 38% in Australia (Vogels et al., 2013). A survey of calf-management practices in Quebec, Canada, found that no farms evaluated colostrum quality or newborn passive transfer status (Vasseur et al., 2010). Survey data in the United States found that 15% of farms tested colostrum quality and only 6% routinely screened for FPT (USDA, 2016).

Another important measure for assessing calf-management success is ADG (Breen et al., 2012), but to our knowledge few dairy farmers track calf weights (Murray and Leslie, 2013) or set specific targets during the milk-feeding period. Moreover, thinking has changed

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considerably about milk-feeding practices: a developing literature indicates that providing more milk earlier in life can improve calf growth rates, reduce disease incidence, and facilitate greater solid feed intake when combined with an appropriate weaning strategy (Khan et al., 2011). Calves given free access to milk will often drink 10 L/d or more (Jasper and Weary, 2002; de Passillé et al., 2011) and are capable of gaining 1 kg/d (Sweeney et al., 2010; Eckert et al., 2015). However, recent US data show that 56% of farms continue to provide milk volumes of 5 L/d or less, and only 22% feed 8 L/d or more (USDA, 2016). Data from 2007 report ADG from birth to 69 d of 0.6 kg/d (USDA, 2010).

Benchmarking is used in many fields, including health care and agriculture (Jarrar and Zairi, 2001; Bogetoft, 2012). Comparing one's own performance with others provides context to reflect on current practices and identify areas for improvement (Meade, 1994; Anand and Kodali, 2008). This approach may be especially useful for addressing complex multifactorial problems that require tailored solutions.

The aim of the current study was to assess the effects of benchmarking FPT and ADG in preweaned calves on dairy farms. We hypothesized that (1) farms would make management changes to improve these outcome measures, and (2) farms that made these changes would experience improved outcomes, but (3) farms that made no relevant changes would not experience improved outcomes.

MATERIALS AND METHODS

Project Design

Dairy farms were recruited from the client roster of the Greenbelt Veterinary Clinic (Chilliwack, BC, Canada). All farms were located in the lower Fraser Valley region of British Columbia, Canada. Inclusion criteria were a Holstein herd, and more than 100 milking cows. Exclusion criteria were current or recent (within the past year) inclusion in another University of British Columbia study, and routine use of a colostrum replacer. Of 19 farms approached, 18 agreed to participate. The average [± standard deviation (**SD**)] size of the farms was 264 ± 110 lactating cows, with a range of 113 to 450.

To facilitate logistics, participants were divided into 2 staggered cohorts, 1 consisting of 8 farms and the other consisting of 10 farms. Each cohort underwent an initial 7-wk period of on-farm data collection (starting in February and April 2014, respectively). Within 4 wk of the end of this initial data collection, we presented benchmark reports to the farms.

After receiving the report, the farms were offered the opportunity to participate in a second assessment period, regardless of whether they made changes. All 18 farms agreed to participate in this second period (identical to the first), starting 24 ± 5 d (mean ± SD) after the initial benchmark report to consider and implement any changes.

Animal care aspects of this study were approved by the University of British Columbia Animal Care Committee (application A14–0245). Survey methods were approved by the University of British Columbia Behavioral Research Ethics Board (application H14-03196).

Data Collection

We conducted a survey of management practices in person during an initial farm visit; the first author interviewed the primary calf caretaker(s) on the farm. Survey items included general practices for preweaned calves, with a focus on colostrum and feeding protocols. At the beginning and end of the second round of data collection, the first author asked farmers to identify changes made over the course of the study.

Following recommended protocols for herd assessment of FPT of immunity (McGuirk and Collins, 2004), blood samples were collected weekly from all calves (heifers and bulls) aged 1 to 7 d. On average (±SD), 22 ± 7 calves were tested per farm during each round (minimum of 12); 380 calves were tested in round 1, and 402 calves were tested in round 2 (Table 1).

Samples were collected by jugular venipuncture in red-top Vacutainer tubes (10.0-mL BD Vacutainer glass serum tube, silicone-coated; Becton Dickinson and Co., Franklin Lakes, NJ) and refrigerated for up to 24 h. The serum was separated by centrifuge (Legend RT, Sorvall; ThermoFisher Scientific Inc., Waltham, MA) at 1,565 × g at 5°C for 15 min and then stored at −20°C until analysis. Measuring serum total protein (**TP**) via refractometry is a valid proxy measure for IgG and a practical method for assessing passive transfer of immunity in calves (Morrill et al., 2013; Deelen et al., 2014; Thornhill et al., 2015). Serum TP was measured 2 or 3 times (until 2 identical readings were recorded) with a temperature-compensating digital refractometer (AR200; Reichert Analytical Instruments, Reichert Inc., Depew, NY) to assess the state of passive transfer in each calf. Failure of passive transfer was defined as a serum TP score below 5.2 g/dL (Tyler et al., 1996; Calloway et al., 2002).

Every second week, heart-girth tape measurements were taken from all preweaned calves ≤70 d of age, to a maximum of 25 animals per visit, with 3 to 4 visits per round. If a farm had more than 25 preweaned calves,