The association between daily average feeding behaviors and morbidity in automatically fed group-housed preweaned dairy calves

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ABSTRACT

Group housing and computerized feeding of pre-weaned dairy calves is gaining popularity among dairy producers worldwide, yet disease incidence and detection remain a challenge in these systems. The aim of this prospective observational cohort study was to describe the relationship between morbidity and feeding behavior around the period of illness detection. Calves were enrolled upon entrance to the group pen on 10 farms in Minnesota (n = 4) and Virginia (n = 6) utilizing group housing and computerized feeding from February until October 2014. Morbidity and mortality events were recorded by the calf caregiver. Farms were visited either every week (Minnesota) or every other week (Virginia) to collect calf enrollment data, feeding behavior data, and health records. Daily average feeding behaviors (drinking speed, mL/min; daily consumption, L/d; rewarded visits to the feeder; and unrewarded visits to the feeder) were described both overall and for sick and healthy calf days. Multivariable mixed models were built to assess the differences in daily average feeding behaviors (drinking speed, daily consumption, rewarded visits, unrewarded visits) between matched sick and healthy calves around the time of an illness event (−10 to 10 d). Final models were controlled for calf age, region (Minnesota and Virginia), group size, disease diagnosis, the random effect of farm, and repeated measurements on calf. A stratified analysis was performed by both day from treatment event and disease diagnosis. We enrolled 1,052 calves representing 43,607 calf days over 9 mo. From these, 176 sick calves had a matched control and were carried forward to the matched pair analysis. Fifty-five percent of sick calves (97/176) were treated for diarrhea, 30% (53/176) were treated for pneumonia, and 15% (26/176) were treated for ill thrift. Sick calves drank 183 ± 27 mL/min (mean ± standard error) more slowly, drank 1.2 ± 0.6 L/d less, and had 3.1 ± 0.7 fewer unrewarded visits than control calves on the first day of treatment. These differences began up to 4 d before the calf was detected as sick, and persisted for 7 to 10 d after treatment. However, changes in feeding behaviors varied by disease diagnosed. Rewarded visits were not associated with morbidity status. The results of this study indicate that sick calves change their feeding behavior before and during an illness event, suggesting that feeding behavior may be a useful tool to detect disease onset.
Key words: group housing, feeding behavior, calf health

INTRODUCTION

Group housing of preweaned dairy calves has recently increased in popularity among dairy producers, with an estimated 15% of farms in the United States housing calves in groups (USDA-NAHMS, 2016). Automatic, or computerized, feeding is one method of delivering milk to group-housed calves. This management strategy has the benefits of facilitating the ability to feed more milk per day (Huuskonen and Khalili, 2008; Roth et al., 2008), reallocation of calf labor (Kung et al., 1997), and social benefits to the calf (Jensen et al., 1999; De Paula Vieira et al., 2012). However, calves housed in large groups (≥7 calves) have an increased incidence of respiratory disease (Svensson et al., 2003; Svensson and Liberg, 2006) and mortality (Losinger and Heinrichs, 1997) compared with calves housed in small groups. In addition, it can be more difficult to detect diseased calves in group housing systems (Steenkamer, 1982). It has been well established that calf morbidity is associated with impaired future performance, including reduced rate of gain, increased culling risk, increased age at first calving, and reduced milk yield (Waltner-Toews et al., 1986; Correa et al., 1988; Virtala et al., 1996; Heinrichs and Heinrichs, 2011). Therefore, understanding how sick calves behave in a group is an important first step to determine management strategies and tools that can improve disease detection and intervention.

Regardless of housing strategy, the 2 most prevalent causes of morbidity and mortality during the pre-weaning period are diarrhea and respiratory disease, accounting for 21.3 and 12% of morbidity and 55.9 and 26.2% of mortality, respectively (USDA-NAHMS, 2016). Infectious and inflammatory processes induce physiological and behavioral changes (Johnson, 2002), including fever, anorexia, lethargy, depression, social isolation, and a reduction in grooming behavior (Hart, 1988), and these adaptive responses have been shown to be important for survival (Kluger and Vaughn, 1978; Murray and Murray, 1979). Infectious disease induction models have been shown to decrease TMR intake in heifers (Steiger et al., 1999) and decrease rumination time, hay intake, self-grooming behavior, and increase the duration of lying behavior in dairy calves (Borderas et al., 2008). Recent work has shown that group-housed calves that have respiratory disease, a fever, or are recovering from diarrheal disease are half as likely to approach a novel object or human as compared with healthy pen mates (Cramer and Stanton, 2015). These studies indicate that calves change their behavior when ill, and suggest that feeding behavior may be a useful predictor and indicator of disease onset.

One potential advantage of sophisticated computerized milk delivery systems over other (manual) milk delivery systems is that computer software can record and report individual calf feeding behaviors that may be useful for disease monitoring purposes. For example, a calf may be flagged by computer software as being a suspect for illness if it shows a deviation (reduction) in daily milk intake as compared with a rolling average. However, there is reason to believe that current algorithms used by computer feeding software lack in timeliness or sensitivity to detect disease events in some calves. For example, Borderas et al. (2009) reported that calves fed a high level ($\geq$12 L/d) of milk drank significantly less milk the day they were detected as sick by an observer as compared with healthy calves, but this behavior change only occurred on the same day as illness detection. Svensson and Jensen (2007) reported that sick calves had a reduction in visits to the feeder without milk (unrewarded), but found no difference in speed of milk consumption or visits to the feeder with a milk meal (rewarded). That work explored associations between health status and some but not all measureable feeding behaviors [i.e., drinking speed (mL/min), visits to the feeder with a milk meal, visits to the feeder without a milk meal, and total consumption (L/d)]. However, these studies had a small sample size and smaller group sizes than are frequently observed in the United States (8 to 13 vs. 20 to 25 calves per group). To better understand how sick calves behave in a group

pen, it is important to do large observational field studies, to capture a better understanding of both variation and the dynamic nature of these systems. The objective of the current study was to describe the relationship between feeding behaviors and morbidity around the time of an illness event. We hypothesized that calves experiencing a morbidity event would exhibit changes in feeding behaviors on the days leading up to and during the sickness event as compared with a matched healthy calf.

MATERIALS AND METHODS

Herd Selection

This prospective observational cohort study was conducted in a convenience sample of 10 commercial dairy herds; 4 herds in Minnesota and 6 herds in Virginia. Herds were selected based on their use of a sophisticated calf feeding system (Forster-Technik, Engen, Germany) and must have had the system in place for greater than 1 yr. Herds also must have provided a peak daily milk allowance of $\geq$7 L per day at a TS level >125 g/L (grams of milk powder added to 1 L of water).

Calf Management and Data Collection

The use of animals in the study was approved by the University of Minnesota Institutional Animal Care and Use Committee (#1308–30844A). Data collection occurred from February 2014 to October 2014. An initial questionnaire was used to describe calf facilities and general calf management. Heifer and bull calves were enrolled into the study when they entered the group pen, and exited the study when they were weaned from the automatic feeder. For each calf entering a group pen, the calf manager recorded the calf id, breed, sex, birth date, and pen entry date. Sick calves were identified based on daily subjective evaluations by the calf manager, and the date, time, treatment, and disease treated were recorded for each morbidity event. Mortality events were recorded similarly. We attempted to standardize case definitions across farms through training and use of a visual scoring system that evaluates ocular and nasal discharge, cough, head tilt, fecal score, and general attitude (McGuirk, 2008).

A study technician visited the farm each week (Minnesota) or biweekly (Virginia), to collect calf enrollment data, treatment records, and mortality data. An 8-mL venous blood sample was collected from the jugular vein of a convenience sample of calves between 24 hr to 7 d of age for serum total protein measurement (g/dL) with a digital serum refractometer (MISCO Palm Abbe