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A study of methods for evaluating the success of the transition period in early-lactation dairy cows

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ABSTRACT

Three transition monitors were developed in this study that serve on 2 levels: the individual cow level and the herd level. On the first level they screen all cows for potential onset of postparturient health disorders and could be used to trigger implementation of more specific diagnostic initiatives. On the second level they can be used within herd to monitor the implementation of transition protocols and evaluate the transition management on the farm, signaling potential problems before clinical disease onset. The performance of 3 transition monitors based on daily milk yield (MY) within the first 7 d in milk was evaluated in 3 herds with differing transition management intensity. The 3 monitors considered were increase in MY (LINE), average MY (MY7), and the difference between MY7 and expected MY (transition success measure, TSM). Transition monitors were evaluated not only as within-herd predictors of individual cow transition problems but also as indicators of herd transition management failures by relating their value with probability of early-lactation health disorders, culling, and treatment cost. Analysis of logistic models, correlations, and sensitivity and specificity estimates identified TSM as the most reliable measure of transition failure on both the individual cow level as well as the farm level across all study herds, with best performance achieved in herds with the most intensive postpartum cow management. As evaluated by logistic regression models, TSM was able to successfully predict the probability of a cow remaining healthy for the first 21 d of lactation (c-statistic between 0.68 and 0.78), and probability of culling by 100 d in milk (c-statistic between 0.73 and 0.86). Total cost of treatment by 21 d in milk also showed the strongest correlation with TSM, with correlation coefficients ranging between 0.2 and 0.4. Statistical-process control cumulative sum charts for TSM designed to monitor postpartum management process in the herd identified transition failure events with at least 90% sensitivity at specificity above 92% within a 14-d window of 7 d before and 7 d after the event.
Key words: transition management, statistical process control, health monitoring

INTRODUCTION

The calving period is associated with reduced immune function and feed intake, negative energy balance, and insulin resistance causing 30 to 50% of the dairy cows to suffer from metabolic or infectious disease during transition (LeBlanc, 2010). Researchers agree that intensive monitoring of fresh-cow health is crucial for further lactational success and have focused considerable research on developing methods of evaluating transition-cow status (LeBlanc, 2010). The main issue in such studies is choosing a performance measure that is strongly related to the physiological balance of the animal (Mertens et al., 2010) and provides information on cow health status as early into the lactation as possible.

Addressing the importance of providing information on the health and disease status of the cow as early as possible (Hachenberg et al., 2007) has led to the introduction of several screening tools such as body condition scoring (Heuer et al., 1999) and blood or urine sampling (LeBlanc, 2010) in the dry period. However, the time lag for blood and urine sampling results, the sampling cost, and increased labor when managing cow testing outside of the milking parlor (Hachenberg et al., 2007) limit routine use of these tests on farm.

Automated sensors detecting health problems in milking cows have been introduced and include milk electroconductivity, milk temperature, activity, and rumen pH meters, to mention a few (Rutten et al., 2013). Individual studies report high sensitivities and specificities of particular sensors. Problems with among-cow and among-farm variability and the choice of the gold standard defining health status persist, whereas uncertain cost-to-benefit ratios of sensor technology question the economic gain of implementation (Rutten et al., 2013).

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Using data that is already available as a prescreening tool to select suspect cows for more definitive diagnostic tests conserves time and financial resources. For example, milk-production data are sensitive to cow physiology, disease status, and management interventions. It has economic value, can be frequently (automatically) collected, and is available on a wide range of dairy farms worldwide. Several studies (Edwards and Tozer, 2004; Lukas et al., 2009) have shown decreased milk production of either sudden or gradual character (Deluyker at al., 1990, 1991) associated with clinical disease symptoms, and Bareille et al. (2003) demonstrated that milk production of cows experiencing clinical signs is compromised from 5 d preceding disease diagnosis. Daily individual-cow milk-production recording is becoming an industry standard, associated with no additional cost or labor, and is readily available on an increasing number of dairy farms, even those not enrolled in DHIA or other herd testing.

Successful development and implementation of a monitor identifying individual animals with suboptimal performance based on their milk production during the transition period would provide timely feedback for additional diagnostic testing and prevention of further clinical-disease development. Common sense would dictate that the earlier into the dry period or current lactation a monitor is available, the greater its preventive value (LeBlanc, 2010).

This study focused on using the individual cow daily milk yield (**MY**) in the first week after parturition for monitoring, considering the following 3 measures: rate of increase in MY (**LINE**), average MY in the first 7 d (**MY7**), and the differences between MY7 and expected MY. This difference is referred to as the transition success measure (**TSM**).

The second purpose of implementing this monitor based on 1 of the 3 measures would be to assess transition management at the herd level. Looking for a way to overcome the inconsistencies in health records within and between farms, Nordlund and Cook (2004) focused on early-lactational performance data as a source of unbiased and standardized information on the transition-cow management program implemented on the farm. Nordlund (2006) used MY and other information gathered during monthly on-farm DHIA testing to develop the Transition Cow Index. He reasoned that dairy farms that engage in routine DHIA testing (around 47% of US herds; AIPL, 2012) can use the Transition Cow Index to evaluate the general health of fresh cows and observe changes in transition-cow management based on comparisons with peers.

Bach et al. (2008) found significant associations between stall maintenance, stocking rate, and feed push-ups and the average MY recorded for the herd. Therefore, continuous monitoring and evaluation of the herd-level MY data can bring focus to emerging cow transition-process issues associated with changes in stocking rate, dairy personnel, feed quality, or other potential periparturient stressors. Statistical process control (**SPC**) is a set of methods that can be applied to continuously evaluate the state of various processes on the farm. Mertens et al. (2010), in a review of SPC methods in livestock production, list 18 studies published in the 8-yr period from 2001 to 2009. Areas associated with reproduction (de Vries and Conlin, 2003), milk quality (Lukas et al., 2005), feed quality (St-Pierre and Cobanov, 2007), water intake, and health management (Lukas et al., 2008; Miekley et al., 2013) have all been monitored using SPC.

Applying SPC to monitor the fresh-cow performance would alert the farm manager of any changes occurring in transition-cow management so that the source of problems can be identified and timely corrective action can be implemented. The goal of such an intervention would be to minimize predisposing stress factors at the onset of lactation that could cause the animals to develop periparturient diseases and forfeit future milk production, and when appropriate management intervention has the greatest potential to positively affect the cows.

The primary objective of the study was to evaluate methods for determining the success of the transition period of individual cows in early lactation. A secondary objective was to evaluate a SPC monitoring method to assess within-herd change in transition-cow management over time, even in herds with limited or no health records.

MATERIALS AND METHODS

Data

Herd A. Individual-cow daily (per milking) milk-production data along with health records were collected from a 230-cow Midwestern freestall and tiestall dairy herd (herd A) between January 2004 and May 2009. A postpartum screening process was implemented from 1 to 14 DIM. Data were available on a daily basis to assess each cow and included MY, MY deviation, feed intake, attitude, rectal temperature, manure consistency, and uterine discharge. If by d 14 all screening parameters were within normal limits, from d 15 to 21, only MY and feed intake were monitored along with a visual appraisal. Declining MY or abnormal findings triggered a complete physical exam. Case definitions and standardized treatment protocols were established for all common health disorders that afflict dairy cows (Lukas et al., 2009). Treatment protocol development, diagnosis, and treatment applications were conducted