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A randomized controlled trial on the effect of incomplete milking during the first 5 days in milk on culling hazard and on milk production and composition of dairy cows

C. Krug,* P.-A. Morin,† P. Lacasse,‡ D. E. Santschi,§ J.-P. Roy,† J. Dubuc,† and S. Dufour*[1]
*Département de pathologie et microbiologie, and
†Département de sciences cliniques, Faculté de médecine vétérinaire, Université de Montréal, 3200 Rue Sicotte, St-Hyacinthe, Québec, J2S 2M2, Canada
‡Centre de recherche et de développement de Sherbrooke, Agriculture Canada, 2000 College, Sherbrooke, Québec, J1M 0C8, Canada
§Valacta, 555 Boulevard des Anciens Combattants, Sainte-Anne-de-Bellevue, H9X 3R4, Canada

ABSTRACT

An incomplete milking in early lactation could help limit negative energy balance in dairy cattle, but its potential effects on culling hazard and on milk production and composition throughout the entire lactation are unknown. The objective of this study was to evaluate the effect of an incomplete milking during the first 5 d in milk on culling hazard, milk weight, milk fat and protein concentrations, and energy-corrected milk (ECM) yield during the whole lactation. A randomized controlled trial was conducted in 13 dairy farms near St-Hyacinthe, Quebec, Canada. Approximately 1 mo before expected calving, Holstein multiparous cows calving between December 2013 and March 2015 (n = 846 cow lactations) were randomly assigned to a control or a treatment group. Cows in the control group were milked conventionally, whereas cows in the treatment group were submitted to an incomplete milking protocol (maximum of 10, 12, and 14 L/d of milk was collected on days in milk 1–3, 4, and 5, respectively). All farms were registered on Dairy Herd Improvement Association, which was used to obtain records on culling, monthly milk yield, and milk fat and protein concentrations. In addition, daily milk yield records were available for 6 farms. A Cox proportional hazards model with a herd frailty term was fitted to the data to compare culling hazard among treatment groups. Regarding milk production and composition, 4 linear mixed models with herd as a fixed effect, cow as a random effect, and using an autoregressive covariance structure were used to study the effect of the incomplete milking on (1) milk weight, (2) milk fat concentration, (3) milk protein concentration, and (4) ECM yield. Culling hazard did not differ among treatment groups (hazard ratio = 1.0; 95% CI = 0.82, 1.3). We observed no differences in milk weight, milk fat, or protein concentration among treatment groups between weeks in milk (WIM) 2 and 44 (the studied period). We noted difference in ECM between treatment groups for WIM 38, with incompletely milked cows producing less milk than conventionally milked cows (−2.7 kg/d; 95% CI = −0.02, −5.2 kg/d), but no differences were found for any of the other WIM. These results suggest that this strategy for controlling the negative energy balance has negligible effect on cow productivity.
Key words: dairy cattle, incomplete milking, culling, milk production

INTRODUCTION

In dairy cows, the transition period is marked by substantial nutritional, metabolic, hormonal, and immunological changes (van Knegsel et al., 2007; Ster et al., 2012). During this period, cows are in a state of negative energy balance (**NEB**) that occurs because the demand for nutrients for milk production increases rapidly and exceeds the supply of nutrients provided by food intake (Grummer et al., 2004). This NEB results in lower blood glucose levels and the mobilization of body reserves to provide additional energy, leading to elevated blood concentration of metabolites, such as fatty acids and BHB (Busato et al., 2002). High concentrations of these metabolites have been associated with a state of immunosuppression (van Knegsel et al., 2007; Ster et al., 2012), increased risk of infectious diseases (Suriyasathaporn et al., 2000), metabolic diseases, reduced milk production (Duffield et al., 2009), and higher culling risk (Roberts et al., 2012).

Decreasing the imbalance between nutrient requirements and energy intake (i.e., the NEB) should reduce the incidence of metabolic and infectious diseases in

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[1]Corresponding author: simon.dufour@umontreal.ca

dairy cows. The classic approach to decrease that imbalance is to increase energy density of the diet offered during this period (Grummer et al., 2004). Another option is to temporarily decrease energy demands, by slowing down the increase in milk production for a few days just after calving. Once a day milking during the first week in milk (**WIM**) seems to have this effect, by temporarily reducing the energetic requirements and, therefore, the NEB (Loiselle et al., 2009; O'Driscoll et al., 2012). However, it also has a negative carryover effect on milk production for the rest of the lactation, possibly due to the lower stimulation of prolactin hormone (Lacasse et al., 2011).

Carbonneau et al. (2012) have shown that reducing milk output by milking cows incompletely (collecting about one third of expected milk production), twice daily until day 5 after calving while maintaining the stimulus of frequent milk removal, improves metabolic status and immune functions without having a carryover effect on subsequent milk production. Although the results of their study are very promising, it was conducted on a limited number of animals (16 treated and 15 control cows) in experimental research station conditions. These results cannot, consequently, be generalized to commercial farms. Therefore, a randomized controlled trial (**RCT**) was conducted on 13 commercial dairy farms to evaluate the effect of an incomplete milking protocol (Morin et al., 2018). The RCT showed a marked decrease in BHB blood concentration and in odds of hyperketonemia among cows milked incompletely. The aim of the present research was to investigate the effect of the incomplete milking protocol on culling hazard and on milk production and composition using the large data set generated by the Morin et al. (2018) study.

MATERIALS AND METHODS

Sample Size Calculations

The original study was designed to investigate the effect of an incomplete milking protocol on ketonemia, odds of hyperketonemia, reproductive performances, odds of infectious diseases (e.g., mastitis, metritis), culling hazard and, finally, milk production and composition (Krug et al., 2017; Morin et al., 2018). Among all the outcomes studied, the outcome requiring the largest sample size was odds of hyperketonemia, which required the recruitment of 400 cows per treatment group (Morin et al., 2018). The sample size for the RCT described in our study was, therefore, determined for answering this latter research objective. Nevertheless, power calculations using the POWER procedure in SAS 9.4 (SAS Institute Inc., Cary, NC) were conducted to estimate the differences in milk weight, fat and protein concentrations, and ECM that could be detected using the available data. Using an α of 0.05, and assuming a standard deviation of 5.0 kg/d for milk weight and ECM and of 0.5 percentage points for milk fat and protein concentrations, we estimated that differences in milk weight and ECM $\geq$1.2 kg/d and of fat and protein concentration $\geq$0.12 percentage points could be detected with >90% power with the available data. Clustering of observations by cow and herd was not considered for these calculations; therefore, the minimal detectable differences presented are likely to be slightly optimistic.

Herds and Cows

Our study was a RCT conducted on multiparous cows from a convenient sample of 13 commercial dairy farms. The complete research protocol is described by Morin et al. (2018). Briefly, to be selected, farms had to be in the vicinity of Saint-Hyacinthe (Quebec, Canada); to accept to follow the standardized research protocol; to participate in a DHIA program; to have computerized health records; to use a milking system allowing measurement of the harvested milk in real time during milking; and to share their herd health, DHIA, and daily milk weight (if available) data with the research group. The study protocol was accepted by the Animal Ethics Committee of the Université de Montréal (rech-1701).

In each herd, all multiparous cows calving between December 2013 and March 2015 were randomly allocated at the time of dry off to a treatment or a control group using a random number generator. Cows in the treatment group were milked incompletely during the first 5 DIM, with a maximum of 10, 10, 10, 12, and 14 L/d collected on DIM 1, 2, 3, 4, and 5, respectively. This protocol was derived from the one investigated by Carbonneau et al. (2012; 6, 8, 10, 12, and 14 L/d on DIM 1, 2, 3, 4, and 5, respectively) in an attempt to make the protocol more practical for milk producers. More specifically, farms with 2 milkings/d were informed to collect 5, 5, 5, 6, and 7 L/milking on DIM 1, 2, 3, 4, and 5, respectively. Farms with 3 milkings/d were informed to divide the maximum amount allowed per day in 3. In the herd using an automatic milking system (**AMS**), cows from the treated and control groups were milked twice a day in the maternity pen during the first 5 DIM and then sent to the AMS for the remaining of the lactation. In all other herds, cows in the control group were milked conventionally according to the farm practices. The majority of farms (12/13) had automatic teat cup removers, with detachment at a mean milk flow rate of 600 g/min (range = 300 to 1,200 g/min). In 6 farms,

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