INCOMPLETE MILKINGS IN AUTOMATIC MILKING SYSTEMS

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Introduction

Automatic milking systems (AMS) rely on voluntary and distributed attendance of cows to the dairy facility throughout lactation. This generates variation in milking intervals (MI), defined as the period of time that elapses between two consecutive milking events, measured in hours. Farmers operating AMS need to manage variation in MI within and between cows.

In AMS a robotic arm locates and attaches a cup onto each individual teat. Success of this task depends on several cow and equipment factors, including localisation and insertion of the teats, which is related to the amount of milk in the udder. Unsuccessful attachment of the cups to one or more teats, and premature cup removal, are some of the causes of incomplete milkings (Lyons et al., 2014).

The aim of this work was to cluster cows according to the risk of having incomplete milkings and to characterize the groups regarding MI, peak yield (Lpeak) and days to peak yield (Dpeak).

Materials and methods

A database containing 773,483 records of automatic milking events for one year (July 2016 – June 2017) from four AMS herds was used (two from Australia, one from New Zealand and one from Chile). Each record contained identification number for herd, cow and lactation, as well as values of days in milk, MI and milk yield (MY, the total amount of milk harvested in one milking event, in liters/milking). Daily milk yield was calculated as the sum of MY within a day. Two ancillary variables were calculated: the phase of lactation (PL) (ascending, peak or descending) in which the studied milking event occurred and the cumulative number of milking events until the studied event (CM). An incomplete gamma function (Wood, 1967), was fitted for each lactation category (first, second and third or more lactation). This allowed us to extract lactation curve parameters and calculate Dpeak and Lpeak. The interval Dpeak ± 15 days was called "Peak phase". The "Ascending phase" was associated to the days from calving to start of peak phase. The "Descending phase" started after the peak phase and finished with dry off.

A mixed Cox model was fitted using package Coxme in RStudio (http://www.r-project.org) to estimate the risk of incomplete milking events as function of MI, PL, and CM by lactation category. The herd and lactation within herd effects were incorporated to the model as random to account for correlation among data from same lactation and herd. The best lineal unbiased predictor (BLUP) of lactation effects were used to rank lactations within herd. Furthermore, cows were divided in low, medium and high incomplete milking risk categories, according to each of three equal groups into which a population can be partitioned applying the BLUP distribution. Finally, ANOVA was used to compare incomplete milking risk categories regarding average values of MI, Lpeak, and Dpeak.

Results

Interaction between PL and CM was significant. This implies that the rate of incomplete milking event varies according to CM and PL. For first lactations cows, the rate of incomplete milking differs between the peak and ascending phase. During the peak phase, with the course of the milkings, the rate of incomplete milking decreases, reversing this relationship in the ascending phase. For second lactation cows, at the peak phase the rate of occurrence of incomplete milking increases with CM in comparison with the descending phase. Finally, for cows with three or more lactations, the rate of occurrence of incomplete milking in the ascending phase decreases compared to the descending phase.

Regardless of the lactation category, the largest MI was observed in lactations with low risk of incomplete milkings. Cows with two or more lactations and high risk of incomplete milking had lower Dpeak than cows of low and mid risk of incomplete milkings. There was no difference in Dpeak according to risk of incomplete milkings for first lactation cows (Table 1). Risk of incomplete milking had no effect on Lpeak for any lactation category, except medium risk of incomplete milking for second lactation cows.

Table 1. Milk yield at peak (Lpeak), days to peak (Dpeak), and milking interval (MI) regard the likelihood of incomplete milking event according to lactation number.

Risk of IM	**1 lactation**			**2 lactation**			**3 or more lactation**		
	Lpeak (L/d[1])	Dpeak (d[2])	MI (h[3])	Lpeak (L/d)	Dpeak (d)	MI (h)	Lpeak (L/d)	Dpeak (d)	MI (h)
LOW	18.38^{a*}	43^{a}	18^{a}	28.50^{a}	52^{b}	17^{c}	35.81^{a}	46^{b}	16^{c}
MEDIUM	18.64^{a}	48^{a}	13^{b}	31.00^{b}	52^{b}	12^{b}	34.69^{a}	45^{b}	12^{b}
HIGH	19.43^{a}	56^{a}	11^{c}	27.87^{a}	44^{a}	9.5^{a}	34.22^{a}	42^{a}	9^{a}

*[a-c] Values within a column with different superscripts differ significantly ($P < 0.05$).
[1] Liters per day; [2] days; [3] hours

Conclusion

There were differences in lactation curves among different risk groups for cows with two or more lactations.
Understanding the behaviour of type of milking will allow the development of management strategies to minimize the proportion of incomplete milkings and maximise the overall system performance.

References

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