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Time-budget constraints for cows with high milking frequency on farms with automatic milking systems

Simone Helmreich [a], Rudolf Hauser [a], Thomas Jungbluth [b], Beat Wechsler [a], Lorenz Gygax [a,*]

[a] *Federal Food Safety and Veterinary Office FSVO, Centre for Proper Housing of Ruminants and Pigs, Agroscope, Institute for Livestock Sciences, Tänikon, CH-8356 Ettenhausen, Switzerland*

[b] *University of Hohenheim, Institute of Agricultural Engineering, Livestock Systems Engineering, Garbenstraße 9, 70593 Stuttgart, Germany*

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ABSTRACT

Adequate lying times and feed consumption are essential for the welfare and performance of dairy cows. The time budget of cows housed in barns with an automatic milking system (AMS) might be constrained in several ways. Cows with a high milking frequency might also have to visit the AMS at night, possibly interfering with their night-time lying behavior. Moreover, competition for access to the AMS might cause some cows to spend more time waiting in front of the milking unit, resulting in a lower milking frequency. In the present study, the individual total duration of stay and time spent per visit in the feeding, lying and waiting area, as well as lying behavior, was therefore investigated in the daytime and throughout the night in relation to milking frequency.

A total of 138 focal cows (day of lactation: 1–200) housed on 4 Swiss working farms with an AMS were automatically tracked for 48 h. Individual lying times were recorded over 7 days with data loggers. The daily milking frequency was calculated from the AMS records and included as a continuous explanatory variable in linear mixed-effects models.

Time spent in the waiting area at night increased with increasing milking frequency. In addition, cows with a relatively high milking frequency had shorter daytime lying bouts, and spent less time in the lying area per visit during the daytime as well as at night. The same individuals also visited the feeding area for shorter times during the day, and on average remained longer per visit in the waiting area at night. The daily time budget of cows with a relatively low milking frequency was not adversely affected.

Cows with a relatively high milking frequency may face some trade-offs in their time-budget allocation, since the increased time spent by them in the waiting area at night as well as their shorter lying bouts might affect their welfare, health and performance. Nevertheless, the overall daily time budget for lying and feeding, and hence the welfare of cows with both a relatively high or low milking frequency, suffered no obvious adverse effects.

1. Introduction

There are varying reasons for using an automatic milking system (AMS) such as flexibility in labor input, milking consistency as well as economic optimization by e.g. increasing the individual milking frequency of the

* Corresponding author. Tel.: +41 58 480 33 84; fax: +41 52 365 11 90.
E-mail address: lorenz.gygax@agroscope.admin.ch (L. Gygax).

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cows. The latter enables the AMS to be utilized to capacity, which in turn improves productivity. In addition to the economic advantages of an AMS, the freedom of the cows to decide on their own milking times and intervals over a 24-h period is usually viewed as an improvement in animal welfare. At the same time, the installation of an AMS results in a decrease in herd synchrony owing to individual lying, feeding and milking times (Winter and Hillerton, 1995; Ketelaar-de Lauwere et al., 1996). According to Sørensen et al. (2002) and Lexer et al. (2009) the use made of barn areas as well as the lying times are direct indicators of the general impact of the AMS on cow behavior. Since adequate lying times and feed consumption are essential for cow welfare and productivity (Campbell and Merilan, 1961; Haley et al., 2000; O'Driscoll et al., 2009), a reduction in time spent on these behaviors is seen to be a sign of discomfort, and thus considered to be negative (Albright, 1987).

Both the frequency and timing of milkings, e.g. milkings at night, can affect the time budget of cows on farms with AMS (Melin et al., 2006; DeVries et al., 2011). Cows with a high milking frequency might have time-budget constraints owing to more frequent milking events. Depending on the length of their minimum admissible milking interval, these cows might also need to visit the AMS at night, which might possibly interfere with their nocturnal lying behavior. By contrast, cows with a low milking frequency might be able to use their idle time for lying, feeding or similar behavior. Some low-ranking cows might require several attempts or longer waiting times to enter the AMS (Wiktorsson and Sørensen, 2004), however, resulting in a low milking frequency and influencing their daily time budget. Consequently, these cows may have less time available for behaviors such as feeding and lying (Ketelaar-de Lauwere et al., 1996; Lexer et al., 2009). In addition, low milking frequencies might cause some cows to experience greater pressure in the udder, resulting in less comfort in a lying posture and consequently fewer or shorter lying bouts (Östermann and Redbo, 2001).

The aim of this study was to analyze time-budget constraints that might be faced by cows with varying milking frequencies on farms with AMS. As we were unable to assess rank directly due to the open environment in the cubicle barns, with infrequent physical conflict and the potential for avoidance among the cows across large distances, we used age as a potential proxy for rank (Šárová et al., 2013). Therefore the cows' total duration of stay in the feeding, lying and waiting areas and the total time spent lying, as well as the time spent per visit in these areas, and the length of the individual lying bouts were investigated, as a function of their milking frequency and age.

2. Materials and methods

2.1. Farms and animals

The study was conducted in Switzerland on 4 working farms with an AMS that had been in operation for at least 6 months (Table 1). In order to guarantee reliable data measurements with the local position measurement system, a barn height of at least 5 m and open construction of the barn area were the main selection criteria for the investigated barns. 2 farms were equipped with the DeLaval voluntary milking system (VMS, DeLaval International AB, Tumba, Sweden), the other 2 farms with the Lely automatic milking system (Model A 2, Lely Industries N.V., Maassluis, The Netherlands). The 2 DeLaval farms used the semi-forced cow traffic system, in which the cows had to pass selection gates to reach either the feeding or the lying area. On one farm, cows could enter the lying area at will, but were diverted through the milking unit on their way to the feeding area ('semi-forced' system). On the other farm, the 'feed first' system was installed. This system gave cows free access to the feeding area, but as they returned to the lying area a selection gate directed them through the AMS via a system of one-way gates, if they were due to be milked. The 'free' cow traffic system was implemented on the Lely farms, i.e. all cows had access to all barn areas at all times. The exception to this was one farm which had a permanently locked waiting area with one-way gates in front of the milking unit. On all farms, the minimum admission interval between two milkings was adjusted individually according to the cow's stage of lactation. Whereas cows with 1–100 days in lactation had a minimum interval between milkings of 6 h, the minimum interval for those with 101–200 days in lactation was 8–10 h. All farms had deep straw-bedded cubicles and a cubicle-to-animal ratio as well as a feeding-place-to-animal-ratio of at least 1:1. On all 4 farms feed was delivered once in the early morning and once in the evening. All farms fed grass-maize silage supplemented by hay. The farms were visited from June to December 2009, with an experimental phase of 2 to 3 weeks on each farm.

The median herd size on the farms studied was 64 lactating cows (Table 1). For the experimental design, a total of 138 focal cows (35 primiparous and 103 multiparous) with less than 200 days of lactation were chosen (Table 1). Focal cows were equipped with a transponder to measure barn-area use. Additionally, 115 of the 138 focal cows wore a sensor to measure lying duration. Before the start of the experimental phase, all focal cows were declared clinically healthy in that they were not currently being treated for any disease or claw disorders, were not lame, and were not scheduled for claw treatment.

2.2. Behavioral measurements

2.2.1. Barn-area use: local position measurement system

In this study, a local position measurement system LPM (ABATEC Electronic AG, Regau, Austria; Gygax et al., 2007) was used to automatically track individual cows. In each barn, 12 to 14 base stations and 1 reference transponder were installed that were all in the direct line of sight of each other. Each of the 138 focal cows wore a transponder around her neck which was polled individually by the system and responded with a signal. The base stations received the signals transmitted by the cow transponder and the reference transponder, and detected the signal receipt time. The data was then transmitted in real time via a fiber-optic-based network to a PC, which then calculated the current position data (x and y coordinates).