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Real time positioning to detect early signs of welfare problems in cows

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Abstract

Biological rhythms are essential for life. There is evidence that the circadian rhythm of activity is disrupted under chronic stress. It may also be less marked during diseases. We investigated if we could detect a circadian rhythm of activity of dairy cows in commercial settings using a real-time positioning system. We used the CowView (GEA Farm Technologies) to detect regularly the individual positions of 350 cows in a Danish dairy farm for five months, and to infer the cows' activity (resting, feeding, standing, and walking) from their position and their movements. We ran a factorial analysis of correspondences of the cows' activities and used the 1st component of this analysis to express the variations in activity. On this axis, the four activities obtained the following weights: resting, -.19; standing, +0.12; walking, +.26; and feeding, +.29. Applying these weights to the proportions of time each cow spent on each of the four activities, we could describe a circadian rhythm of activity. We noticed that the average level of activity of a cow on a given day and its variations during that day varied with specific states: heat, lameness, disease. This offers the possibility to design models to predict physiological or pathological states of cows from real time positioning.

Introduction

Biological rhythms are essential for life. While diurnal animals are more active during the day, nocturnal ones are more active at night. This pattern is species specific. There is evidence that the circadian rhythm of activity is disrupted under chronic stress. For instance, in rodents (nocturnal species), more activity is observed during the dark period and less during daylight when animals are submitted to a repeated stressors or inescapable electrical shocks (Stewart et al 1990, Solberg et al 1999). We also noticed in cattle that the circadian variations of activity were less marked two days before the occurrence of symptoms of pneumonia (Veissier et al 1989). These latter results were obtained by serendipity, during an experiment on the stabilisation of activity rhythms after the animals were turned from pasture to indoor

conditions and during which an outbreak of pneumonia occurred in the course of the observations. These results had never been confirmed, since they require heavy observations.

We investigated if we could detect a circadian rhythm of activity of dairy cows in commercial settings using a real-time positioning system and if this rhythm depends on the state of the animal.

Material and methods

During the EU-PLF project (<http://www.eu-plf.eu/>), INRA and GEA Farm Technologies collaborate to run field tests using the GEA CowView system (<http://www.gea-farmtechnologies.com/hq/en/mediacenter/news/2012/dlgcowview.aspx>). The CowView is based on real time positioning of animals, with a precision of 50 cm. The position of the cow is allocated to the different zone structures in the barn (cubicles, feeders, corridors...). The activity of a cow is inferred from its allocation and its movements to:

- the cow is considered to be resting if it is found in a cubicle,
- the cow is supposed to be feeding if it is classified within the feed bunk zone,
- the cow is supposed to be standing in the alley way if it does not move in the alley zone,
- the cow is assumed to be walking in the alley way if it moves in the alley zone.

The data from the 350 cows from a commercial farm based in Denmark were collected for five months. They consisted of hourly accumulated activities as determined by the CowView system and all events recorded by the farmer (interventions on the herd, oestrus, lameness, mastitis, accident, calving, respiratory problem, diarrhoea,...).

To determine activity levels and their variations during the day, we needed to attribute a weight to each of the four activities distinguished. Those weights were calculated according to the method proposed by Veissier et al. (Veissier *et al* 2001). The weights were obtained from a factorial analysis of correspondences. On the first axis of the analysis, the four activities obtained the following weights: resting, -.19; standing, +0.12; walking, +.26; and feeding, +.29. This axis was considered to express the level of activity. For each cow, we then calculated its level of activity per day and per hour within each day and the size of circadian variations (the sum of the squares of the deviation of each hour from the average of the day).

Finally, we ran a variance analysis to relate the average activity level of a cow on a given day and its circadian variations to the events recorded by the farmer (Proc Mixed procedure of SAS for repeated measurements).

Results

The cows were active from 08:00 to 21:00, with two peaks of activity, one in the morning and one in the afternoon. The activity was minimal at night (Figure 1).

We divided events recorded on the farm in five categories: control days, oestrus, lameness, infectious disease, and interventions that may affect cows' behaviour such as vaccination, claw trimming... (the data from the days with an intervention were discarded from the analyses). We observed a higher activity in case of oestrus and infectious diseases. The circadian variations were less marked in case of infectious diseases. They were slightly less marked in case of oestrus and lameness (Table 1).

Figure 1: Diurnal variations of activity-level in 350 cows in a Danish dairy herd observed for five months.

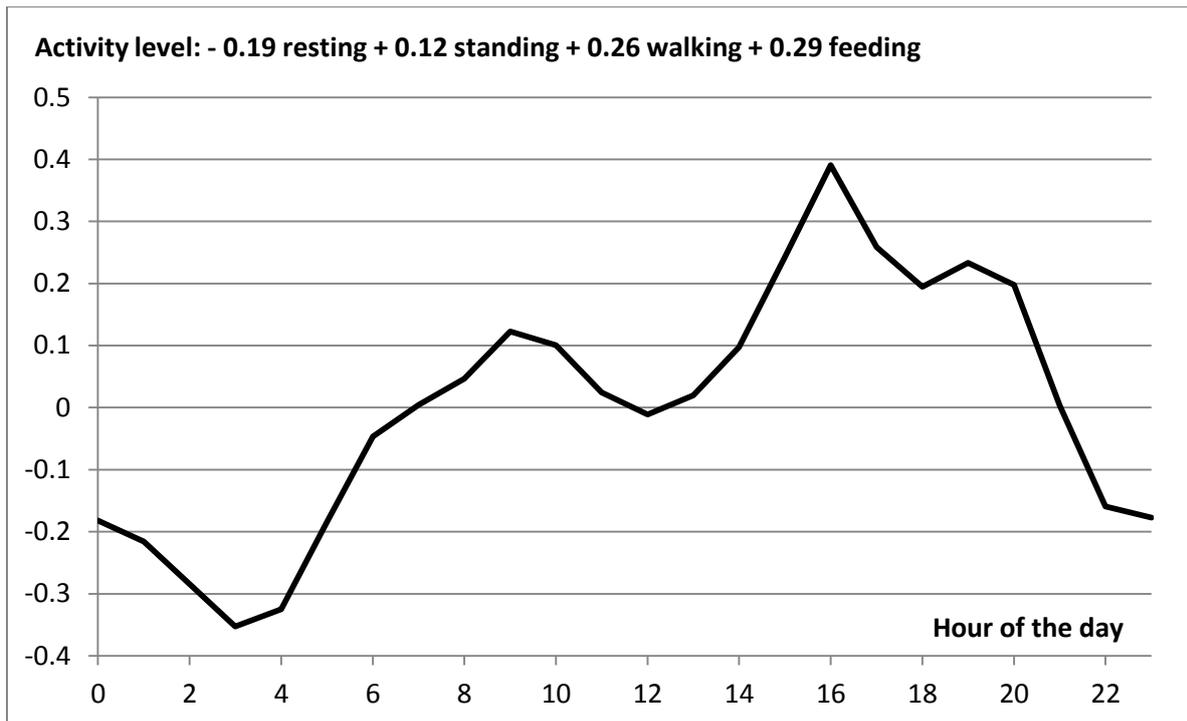


Table 1: Average activity level and circadian variations in activity level in the 350 cows from a Danish dairy herd observed for five months.

	Control days	Oestrus	Lameness	Infectious diseases	SEM	F	P
Activity level	-0.285 a*	0.90 b	-0.17 a	1.73 c	0.107	249	<0.0001
Circadian variations	2.83 c	2.67 b	2.63 b	2.32 a	0.05	54	<0.0001

*on each row values with no common letter differ significantly

Discussion

From the results obtained in this study it seems possible to distinguish the state of a cow: a diseased cow seems to be more active (at least at the very beginning of a disease) but its

activity is less variable during the day. The same is observed for a cow in oestrus but to a lesser extent. Finally a lame cow seems to have a less variable activity during the day. If these results are confirmed in other settings, they offer the possibility to design models to predict physiological or pathological states of cows from real time positioning.

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