MooMonitor+ Smart Sensing Technology and Big Data - Resting time as an indicator for welfare status on farms

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Abstract

A healthy and happy cow will produce more milk and is more likely to live longer. The European animal welfare legislations acknowledges sentience in farm animals. Dairy cows are considered sentient creatures with the right to express natural behaviour and to have provision of the animal's basic needs. Included in this is an emphasis on the owner regards animal welfare and cow comfort. Resting time can be used as an indicator of welfare in different farming systems. Resting enhances blood flow through udder tissue and the gravid uterus. It improves overall claw health while reducing stress and increasing cow comfort. This is reflected in the animal's health status and her reproductive performance and productivity. On the other hand, long bouts of increased resting time can be an indicator of welfare problems. The MooMonitor+ (Dairymaster, Causeway, Co. Kerry, Ireland) system automatically identifies different behaviourisms of the cow and is used to detect estrus, health and welfare events in cows by means of monitoring activity, feeding, rumination and resting time. Using this commercially available device a trial was set up to determine welfare status on dairy farms. This paper interprets and discusses the trial in relation to the impact of season, house design, lameness, production system and overall health on resting time.

Keywords:MooMonitor+ Smart Sensing Technology, animal welfare, resting time, sustainability,

Introduction

Since 1 December 2009 the Lisbon Treaty incorporates the legal recognition of animal sentience. This means that full regards needs to be paid towards the welfare requirements of animals. Numerous studies in the past have shown that improved welfare increases milk output (Fourichon, *et al.*, 1999; Haley, *et al.*, 2001; Regula, *et al.*, 2004). With eye on the future of dairy farming - expanding herd sizes and ultimately space and environmental emission constraints - it seems the most logical step to start getting more milk from the same animals by improving their circumstances on farm. Accordingly longevity in dairy livestock should be a goal to strive for. Milk yield increases per parity up to the 4th and 5th lactation to decrease slowly afterwards (Vlaamse Overheid, 2008). But even in the 6th and 7th lactation significantly more milk is produced compared to production levels of heifers. With this in mind and the fact that adult animals use their energy more efficiently, farm managers can opt for a more sustainable herd profile with higher and longer life productions of the same animals.

In order to improve sustainability at farm level, attention must be paid to the overall health and comfort status of the animal. Animal welfare plays a big part in this. The American Veterinary Medical Association defines animal welfare as - an animal that is healthy, comfortable, well-nourished, safe, able to express innate behaviour, and that is not suffering from unpleasant states such as pain, fear, and distress (AVMA, 2013). One of the key indicators to identify animal welfare in cows is monitoring resting time. A dairy

cow rests on average between 10 and 14 hours per day (Drissler, *et al.*, 2005; Cook, *et al.*, 2005). Longer resting times are considered beneficial to both productivity and overall claw health (Metcalf, *et al.*, 1992; Cook, 2008). Too little or excessive resting however can both be an indicator of sickness, stress, pain, poor shed design, management defects or overall malaise of the animal.

Monitoring welfare by means of automated data recording has proven its value in the past already. Among others data loggers, videotaping material, automatically weighing feed troughs and activity monitors have successfully been used to record different indices that are correlated with a cow's welfare status on farm (Hussey, *et al.*, 2005; Ito, *et al.*, 2010; Mattachini, *et al.*, 2011). This shows great value for commercially available accelerometer technology that uses smart sensing software, such as the MooMonitor+. Different behaviourisms can be accurately identified and used in daily farm management. Although much is written about dairy cow welfare especially concerning lameness and mastitis, little is known about the impact of a generalised common health event on the average total daily resting time of the individual cow if monitored automatically. In this trial we focussed on this one aspect of cow welfare. The goal of this study was to investigate any existing correlation between automatically monitoring daily resting time in cows and the occurrence of health events and whether this feature can be used in cow welfare protocols in future.

Materials and methods

Data collection

In this trial resting time for cows affected with one or more health event - or other events that affects cow welfare - was recorded and by means of statistical analysis compared to daily resting time of healthy cows. To record resting time cows were fitted with a MooMonitor+ collar (Dairymaster, Causeway, Ireland). This is a commercially available device that measures the cow's neck movements using nanotechnology. The device is able to distinguish different types of behaviour and can aid in heat detection, health monitoring, feed conversion calculations and overall herd management. One of the behaviours it identifies is resting time. Every 15 minutes information is transferred back from the device to the cloud server and gives a measurement of how long the cow was resting for in that 15 minute period (alongside other behaviours).

Animals and health events.

For the data analysis resting time data of 172 cows from 1 commercial herd over a 4 month period were collected. A subset of data was observed for different types of health related events that were present during this time frame. Different types of disorders were included in this list such as mastitis, lameness, diarrhoea, displaced abomasum, retained foetal membranes, metritis and others. All these events were brought together under the common denominator 'health event'.

Statistical analysis

Health events were translated into "sick days". An animal was considered sick 4 days before and 4 days after the health event was given. A total of 391 "sick days" were found. Total daily resting time of sick days was then compared to total daily resting time for non-sick days. The contrast between resting time on "sick days" and "normal days" was calculated. This is the average difference between resting time on the days around a noted health event and other days for the same cow.

Results

The total length of the trial data set was 126 days. In total 14,087 records were used for the trial. For the 391 "sick" days, each cow rested on average 101 minutes (P<0.001) longer than that cow rested on other days. A 95% confidence interval (CI) for this contrast is 92-110 minutes. Also in the period around the health event (-4 to +4 days) cow's activity levels remained (sub) normal and a reduction of increased activity was observed (Table 1).

Table 1. Characteristics of resting time data in this trial.

Characteristic	Data
Number of animals	172
Length of trial[1]	126 d
Days sick[2,3]	391 d
Daily resting data cows on normal days	511.64 (508.03; 515.24) min/d
Daily resting data cows on sick days[2,3]	612.84 (593.29; 632.40) min/d
Surplus resting on sick days	101.20 min/d

[1]List of health events and real time resting data recorded in the period 01/01/2015 till 06/05/2015.
[2]Sick days includes health event +/-4 days.
[3]Health events included cases of abscess formation, bloat, diarrhoea, displaced abomasum, leg or hip injury, lameness, mastitis, metritis, retained foetal membranes, rumen pathology and indigestion.

Discussion

Cow welfare in the dairy industry is becoming increasingly more important these days. A dairy cow needs to be looked after in correlation with certain standards pointed out in European legislations. Moreover, contemporary consumers put more and more emphasis on the origin of their products. Milk should ideally come from well treated healthy cows with low cell counts, top diets and living in a stress free environment. Milk co-ops that want to distinguish themselves from their competitors can do so by listening to these consumer requirements. They present various obligatory health and welfare guidelines on top of the European legislations to be followed by their milk producers. If they conform to all legislations and guidelines producers gain status and better payment amongst their peers enabling themselves as well as the other producers to produce a product at a higher quality level. This benefits the competitive market strategy of Europe and at the same time enhances product quality.

A cow expresses both her physical and physiological well-being in her behaviour. When behaviour changes this can often be associated with a health event and this in turn will affect her well-being. Automatically monitoring resting time can accurately identify these changes and can be used in daily farm management routines (Vasseaur, *et al.*, 2012). This will aid the farm manager with making interventional decisions concerning welfare management. Welfare of cows can be improved by adjusting shed layout, flooring, cubicle design, ventilation, animal handling facilities, overall farm management, sick cow management, culling policies, milking technique, milking equipment and many others. Even small adjustments such as introducing a mastitis cow protocol or a more comfortable bedding material in the cubicles to increase resting time can have a massive influence on the cow's performance (Cook, 2008; Cook & Nordlund, 2009).

Hours spent resting per day varies among different shed layouts. In a study done by Haley *et al.* resting time was used as an indicator of well-being in cattle to evaluate stall floor design and quality (Haley, *et al.*, 2001). Resting time increased for animals when shed layout became more comfortable. Season also seems to play a role in average daily resting time. Animals appear to lie down more in the winter months than in summer. However, geographical location, behavioural thermoregulation and climate seem to have a major effect on these records (Steensels, *et al.*, 2012). When cows suffer from heat stress they tend to lie down less hours per day. This could be an explanation of greater resting time records in winter than in summer (Allen, *et al.*, 2013). This study however was performed over a 4 month period which is too short of a timeframe to take these kind of environmental differences into account.

In this trial welfare status of individual dairy cows in one herd were mutually compared by means of measuring resting time data. Cows with health events rested on average 101 more minutes per day than healthy cows (CI: 92 to 110 minutes). This is in agreement with findings of Dantzler that sketches the typical image of a sick animal by means of non-specific symptoms of sickness namely lethargy, anorexia and social withdrawal which includes fatigue and increased resting (Dantzler, 2001). Health issues included in the trial were among others: mastitis, diarrhoea, injuries, retained foetal membranes, displaced abomasum, various rumen pathologies and lameness events. Ito *et al.* found that resting time of individual cows increases with the incidence of lameness events. Severe lame animals were resting on average 12.8 hours per day (CI: 12.0 to 13.7) compared to 11.2 hours per day (CI: 10.7 to 11.8) and had longer duration of lying bouts. The study also points out that cows that on average rest > 14.5 hours per day are at greater risk of experiencing a severe lameness event (Ito, *et al.*, 2010). In contrast Siivonen *et al.* found that resting time of animals decreased in the case of an acute clinical mastitis event. A possible explanation for this is that in case of very swollen udder tissue the animal tries to cope with both swelling and pain and would do the exact opposite of what one would expect - by trying to avoid the swollen tissue to rest on the surface when lying down. With other words pain in udder tissue can override the motivational status of the animals and therefore affect daily resting time negatively. In accordance with their study results a higher level of restlessness was discovered in these cows (Siivonen, *et al.*, 2011). Restlessness is another feature that can be monitored by the MooMonitor+. However more research is necessary to value the impact on the daily measurements of the device concerning acute clinical mastitis cases.

In the period around health events (-4 to +4 days) it was observed that in many cases activity levels of the animals in this trial were below normal and animals experienced a reduction of activity intensity as well in this period. This phenomenon could be explained by the body's need for rest in the early stages of disease as a central motivational state to promote recovery (Kelley, *et al.*, 2003) where the non-specific symptoms such as fatigue and anorexia are preceding the more typical clinical symptoms. Recognising early stages of disease by measuring daily resting time can be helpful in detecting health events automatically.

Conclusions

Daily resting time plays an important part in expressing a cow's emotional and physical health status. It can be used as a key indicator for monitoring cow welfare on farm. In this study one aspect of animal welfare - namely health - was observed to find out the effect a health event has on the daily resting time of an individual animal. It is concluded that in this study animals experiencing a health event rest on average 101 minutes longer (CI: 92 to 110 minutes) than animals that are not experiencing a health event. Also, sick animals can be subjected to a period of reduced activity intensity compared to healthy cows. These stats express the ability of the MooMonitor+ system to detect changes in daily resting time caused by various health events. Likewise, analysis of daily resting time data offers great potential as a farm management tool and this feature could be incorporated in various cow welfare protocols on farm.

List of references

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