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Early recognition of calve diseases with the help of electronic pedometer

The rearing of calves in outdoor climate barns is emerging in larger dairy farms. In the first few weeks mortality and morbidity events seem to be the main problem. Among the technique of direct observation and the estimation of vitality, pedometer measurement systems help to detect animal diseases early and sucessfully. The study shows that behavioural abnormalities can be identified with the help of these methods. Further it was shown that the automated evaluation of the locomotor activity contributes to the improvement of animal health. In view of the decrease of mortality- and morbidity-rate the individual data determined by pedometer measurements shall be used as a management tool in the rearing of calves.

Keywords
outdoor climate barns, pedometer, locomotor activity, lifestock husbandry, calf behaviour, lifestock healthcare

Abstract
Landtechnik 66 (2011), no. 6, pp. 448–452, 5 figures, 1 tables, 11 references

The lasting structural changes in agriculture are leading to increasing farms and animal yields. Careful animal observations are required to detect clinical symptoms of infectious diseases at calves as early as possible. Prophylactic health measures in addition to precise animal monitoring and sensor-based technics of pedometer are allowing medical treatment in large animal populations as quickly as possible.

Furthermore a higher birthrate of calves in increasing animal populations implicates a demanding workload. This can be reduced by the use of automatic feeders. In contrast the milk feeding conventionally occurs by bucket. This method equates the natural behaviour of calves in a group by drinking milk at the same time. The question comes up to what extend the behaviour of the animals can be influenced by a different feeding technology.

Problem/Thesis

With regard to the mortality and morbidity rate during the first weeks of life you should attach importance to the optimal rearing of calves. There are physiological as well as ethological intra-and inter-individual differences. To come up to the requirements of animals in a group and the conscientious observation and workload of the farmer, the use of automatic pedometer can take on an important control function.

Methodology

The data of calves from birth (n = 442) were recorded in the period of studies from 2006 to 2008. After a period of 14 days in a single box, the calves were divided into groups that live on litter in outside barns. The operational removal of barn of male animals has been done after 35 days. The phase of weaning of milk was in the period from 69 to 89 days of life. After the colostrum-milk-administration for five days, the application of milk conventionally occurred by bucket three times a day. In the second part of the investigation milk was given by automatic feeders for a period of 77 days. The differences between the methods of milk application (bucket or automatic feeding) consist in the timing of the milk intake (**Figure 1**). The bucket feeding offered milk to calves from 5:30 o´clock in 6-hour rhythms simultaneously. The automatic-milk-feeding occured with a daily maximum frequency of six visits, depending on the feeding ration. In addition to milk feeding, hay and calves mixed ration were offered.

There were used ALT pedometers for the recording of data of calm and activity behaviour. These pedometers conduce to the time interval related collection and continuous recording of step activity (A), resting time (L) and the ankle temperature (T). The dimensions of pedometer were 60 x 50 x 20 mm. The fitting of pedometer was at the front leg of the calf with commercial ankle straps and metal buckle (**Figure 2**). The pedometers were made for adult animals so that the adjustment to calves had to be done by wristbands. Tepefom was used, a water-repellent flexible polyethylene foam material.

Fig. 1

Milk drinking system with application by bucket (left) and automatic feeding (right) (photo: Fröhner)

Fig. 2

ALT-Pedometer on front leg of the calf (photo: Fröhner)

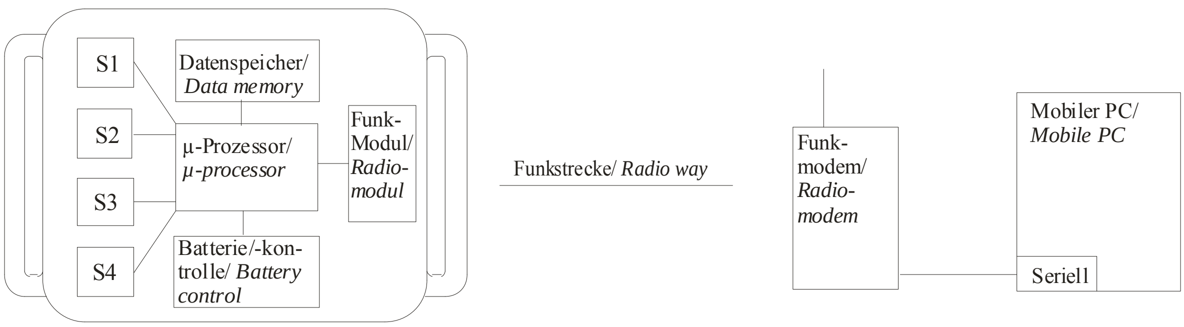
The pedometer system consisted of the components logger and modem (**Figure 3**). The μ-processor recorded the step activity and lying positions of the animal continuously every 15 seconds and added them to the configured sampling interval of five minutes. Furthermore the memory unit and the radio module for wireless data transfer were included.

The allocation of the animals according to their health status was done by individual assessment of their general state of health and the medical attendance of vets. These estimations were visualized via a vitality code that is based on the data recording of reactivity, digestive disorders, nutritional status and milk intake. So the health status of the animals are defined to be healthy (free from disease-indicating variables) or sick (animals that were treated in veterinary medicine or a disturbed general condition). The disease period was five days, including unclear days.

Results

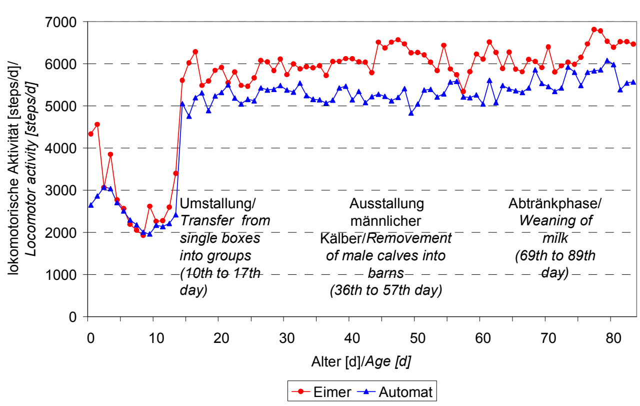
Results of investigation ethological behavioural parameters with help of automatically based pedometer technic showed differences at different feeding technology. The locomotor activity was higher in feeding by bucket than with automatic feeder (**Figure 4**). The activity level by automatically feeding was relatively constant with a slight upward trend over the period in group management. The increase of locomotor activity was highest after the transfer from singlebox in groups and approximately constant on 20 until the 35 days. At this time started the depopulation of male calves, which continued until the 57th day of life. The weaning of milk finished after 12 weeks. Fluctua-

Fig. 3



Circuit diagram of the ALT pedometer; S1-S4 = sensors for activity, lying time and temperature [1]

Fig. 4



Influence of the milk drinking system (with bucket or automatic, n = 114/150) on locomotor activity [steps/day] stating operational influences

tions in level of locomotor activity were in period of weaning of milk and the change to mixed feeding ration.

The range of parameter locomotor activity (steps) indicates large individual differences. This showed a reference curve created of healthy animals. Based on the daily rhythm of healthy animals the locomotor activity of healthy and diseased animals was seen above and below the reference. Two healthy animals were shown to illustrate the variation of records of daily average values (**Figure 5, left**). Veterinary care of animals led to impairment of locomotor activity. Drug treatment at respiratory diseases reduced locomotor activity (animal ID 18,198,151: treatment from 24th to 25th and 30th day of life, animal ID 18,198,249: 16, 24 to 30, 33 and 58 days of life), **Figure 5, right**.

The age-appropriate calculation of variation coefficient (cv) showed smaller deviations of mean locomotor activity at healthy animals (**Table 1**). The classification of animals into age groups was crucial for development of animals and rearing related aspects. Calves housed in individual boxes about the first 14 days of life, when animals stood in a physiological adaptation process. Animals adapted to new housing environment and conspecifics in period from 15 to 28 days of life in group housing. During the period of the 29th to the 56th day was the depopulation of male calves for fattening. Therefore were predominantly female calves in the group from 57th to 84th day.

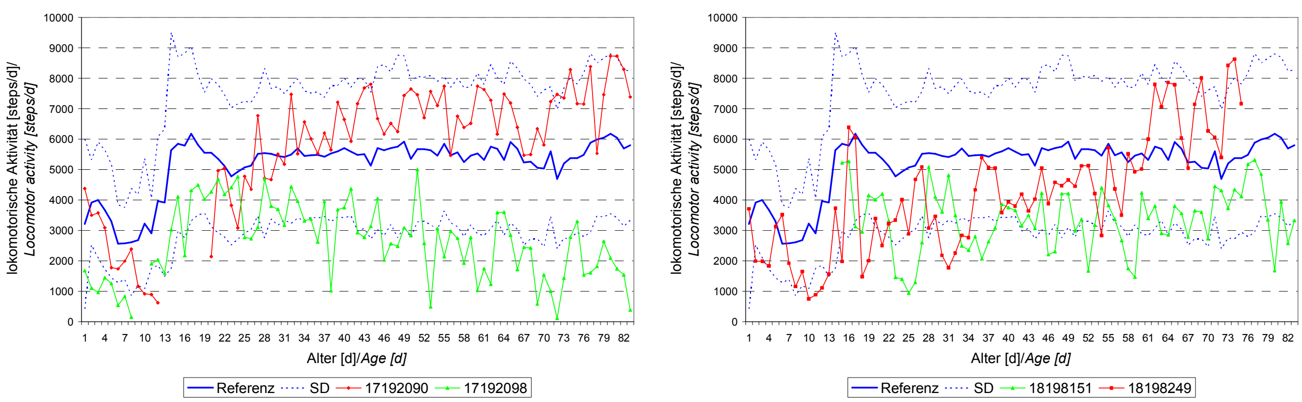
Discussion

The records of the activity profiles of healthy and diseased animals showed a low level of activity in individual stalls, which was justified by the limited space of the calves. The calves have got to be used to deep litter pens with more space, and to conspecifics in the second test section used to automatic feeders, which led to changes in behaviour observation period. In previous studies the adaptation period of calves to new entertainment environments with 10 to 12 days was estimated [2]. Increased locomotion is also associated with social interactions with ample space [3].

The selection of two healthy calves in reference to the total number of healthy animals with the existing data shows significant intra-individual differences in activity levels. Thus, the temperament of an animal could be used to describe the adaptation of calves to housing conditions [4]. Moreover, it was assessed at bustling calves in comparison to the medium and calmly ones that they had the best physical development which was seen in the form of the largest daily gains [5]. With such individual differences at healthy animals, which are reflected in their temperament, an indication of an affection is difficult, because both, healthy and sick animals move outside the reference range of healthy animals [4].

The behaviour is an important indicator of healthiness and wellbeing of the calves. Sick animals, which usually decrease their vitality, reflect that fact in their movement patterns. Using measurements of daily activity in locomotor activity lower mean times were shown at diseased calves [4]. At a high variety of individual animals, large variations were increased by health

Fig. 5



Mean locomotor activity [steps/day] of healthy animals (reference, n = 136) and standard deviation. Two healthy animals are illustrated on the left and two diseased animals on the right

Table 1

Variation coefficient [cv in %] of locomotor activity from healthy and diseased animals with bucket or automatic drinking system (from 1st to 84th day)

Lebenstage *Days of life*	Eimertränke/*Bucket*				Automatentränke/*Automatic drinking system*			
	gesund/*healthy*		krank/*diseased*		gesund/*healthy*		krank/*diseased*	
Von – bis *From – to*	cv	n	cv	n	cv	n	cv	n
1–14	27,75	3	35,71	1	40,14	55	44,03	28
15–28	26,05	57	18,34	1	34,24	98	49,11	5
29–56	24,72	96	28,23	3	29,73	107	32,99	10
57–84	24,42	59	–	0	32,89	68	29,64	2

problems. Drug treatments were performed after the detection of health problems and the consulting of a veterinarian by the pet owner. This implies both high staffing requirements and time loss. The direct losses and the high costs are as problematic as the consequential damages, such as performance depression and a prolonged rearing period [6].

Calculations of the coefficients of variation lead to mostly lower variances in healthy calves, whose significance has been confirmed in other studies [7]. The results allow the statement that with increasing variability the contingent of diseased animals increased [4]. At clinically healthy animals differences in the movement, resting and feeding behaviour were observed.

These differences indicate a disturbed well-being of calves [7]. For this reason intensive animal husbandry comprehensive behavioural observations are required. The pedometer can be seen as a suitable technical aid. This is followed by other authors. They found a reduced activity at least two days before a visual assessment of the diseased calf that was meant to be "sick" [8]. This calf had also a significantly lower level of activity [9].

In several examination it was shown that diseases of behavioral changes are associated with altered food intake and drinking behavior. A few days before significant clinical symptoms appear, one can see reduced feeding times and lower concentrated feed and roughage input [7]. The authors identified in diseased animals larger fluctuations in behavioural parameters (standing and lying time), which were confirmed in additional studies based on the absorption rate and feed intake parameters locomotor activity [10]. The parameter "drinking behavior after assignment" can be used for an early detection of diseases, because weakened calves decrease the drinking activity [11].

Conclusions

The automated determination of locomotor activity may contribute to improvements of animal health. The age-dependent characteristic curve of activity shows fluctuating daily mean value and individual differences. The recording of locomotor activity can be used to show early impairment of movement behaviour of calves. A more differentiated course of disease could be shown by using detailed records about cause, start and development of a disease. This leads to an early intervention before noticeable symptoms in the disease process will occur. In terms of a reduction of the morbidity and mortality rate the individual animal-related data of pedometer should be used in future as a tool for the management in rearing of calves. Health monitoring could be established in the form of alerts that trigger when limit values will be exceeded.

However an intense visual observation of animals is still required additional to the use of computerized monitoring systems in calf rearing. The health monitoring can be supported by using behavioural analysis and alarm lists.

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