Article

A field investigation of the use of the pedometer for the early detection of lameness in cattle

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Abstract — The efficacy of the pedometer to predict lameness earlier than the appearance of the clinical signs in a herd of dairy cows was investigated by correlating pedometric activity (PA) with clinical cases of lameness.

The computer program was set to identify cows with a reduction of 5% or more in PA compared with their own previous 10 days average; these animals were then examined for clinical lameness. At the same time, every lame cow was checked to see if and when its PA was reduced.

Forty-six cows showed a reduced PA; 38 cases of lameness were identified by either a reduction in PA or clinical observation; of these, 21 lame cows (45.7%) showed a reduction in PA of 5% or more, 7 to 10 days prior to the appearance of clinical signs. This cohort comprised 55.3% of the lame cows. In 92% of the lame cows identified by PA, the decrease was above 15%.

Résumé — Une étude sur le terrain de l'utilisation du pédomètre pour la détection précoce de la boiterie chez le bétail. Cette étude évalue l'efficacité du pédomètre pour prédire les boiteries dans un troupeau de vaches laitières avant l'apparition de signes cliniques en établissant une corrélation entre l'activité motrice et les cas cliniques de boiterie.

Le programme informatique a été réglé de façon à identifier les vaches avec une réduction de l'activité motrice de 5 % ou plus comparativement à leur moyenne des dix jours précédents; ces animaux ont ensuite été examinés pour détecter les signes cliniques de boiterie. En même temps, les vaches boiteuses ont été étudiées pour voir si et quand leur activité motrice avait été réduite.

Quarante-six vaches ont eu une activité motrice réduite et 38 cas de boiterie ont été observés soit par une diminution d'activité motrice ou par observation clinique. Chez les vaches avec réduction de motricité, 21 (45,7 %) ont montré une réduction de 5 % ou plus, de 7 à 10 jours avant l'apparition des symptômes cliniques. Cette cohorte représentait 55,3 % des vaches boiteuses. Chez 92 % des vaches boiteuses identifiées par l'activité motrice, la réduction était supérieure à 15 %.

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Introduction

Clinical lameness causes considerable financial loss to the dairy farmer due to decreased production, delayed estrus, delayed conception, and other indirect losses (1). Digital diseases in dairy cattle are estimated to cost $10 million/y in Quebec, and $45/cow/y in Australia (1). Early discovery and, consequently, early treatment would decrease the time to full recovery, thus reducing the financial burden on the farmer.

In dairy cattle, most cases of lameness associated with the hoof that are not due to trauma are due to sequelae of subclinical laminitis, such as white line abscesses and double sole (2,3). Such lesions develop slowly, until the pain increases to the point of interfering with the animal's locomotion and is presented as clinical lameness.

In the Kibbutz Tzora herd reported here, the prevalence of clinical lameness was comparable with the overall national average of lameness in high producing Israeli milking herds, reported as 13.2% (4).

The pedometer is an electronic device that transmits information about the number of steps that the cow takes over a set time. In the literature, there are reports about increased pedometric activity (PA) in cows in estrus (5–8). Significant differences between the PA of sick and healthy cows in the same herd have also been reported (9). Furthermore, a decline in PA could be detected at least 5 to 6 d prior to the onset of clinical lameness (10). Preliminary observations on this topic have been reported (11,12).

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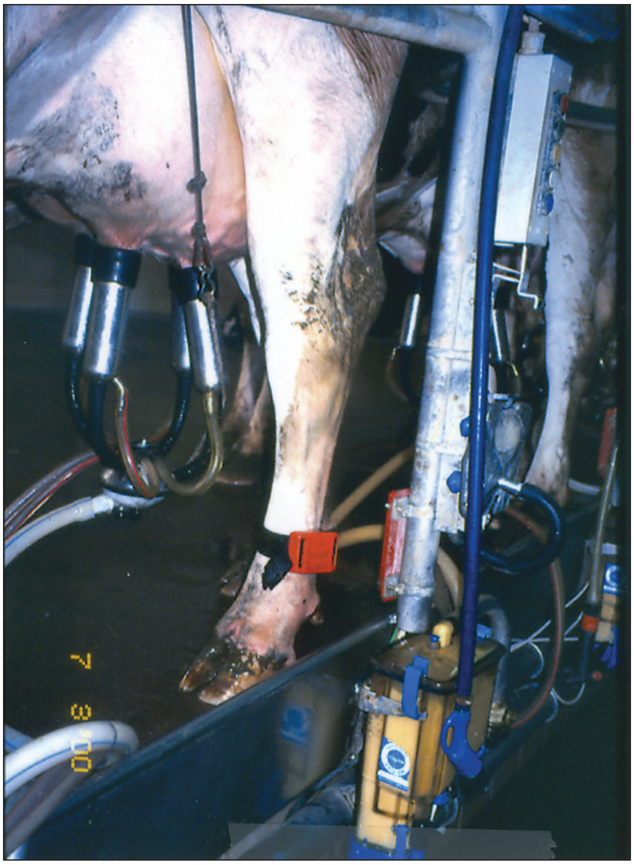

Figure 1. Photograph of a cow's hind leg during milking. The pedometer is attached to the metatarsus of 1 leg proximal to the fetlock. It measures the average number of steps taken per hour since the previous milking. The receiver is attached to a pole (red device) and transmits the data to the computer during milking.

The objective of this study was to test the hypothesis that in most cows that become lame, a reduction in PA can be observed several days prior to the onset of clinical lameness.

Materials and methods

Animals

The investigation was carried out from September 1998 to December 1999 in the herd belonging to Kibbutz Tzora in Israel. The herd consisted of about 400 Israeli-Holstein milking cows, averaging about 11 000 kg milk/cow/y. The herd was housed in open sheds on concrete floors. The cows were bred by artificial insemination. The study was conducted on lactating heifers and mature cows.

Instrumentation and data analysis

The milking parlor operated a pedometer (S.A.E AFIKIM; Tzacham Afikim, Kibbutz Afikim, Israel), combined with a software program (Afikim 2000; Tzacham Afikim). It measures the average number of steps/h that the cow has taken since the last milking and transmits the data to a receiver during milking. Each cow in the milking line carried a pedometer attached to the metatarsus, just proximal to the fetlock (Figure 1) and the data were recorded daily. The recorded data from each cow were processed by the computer to produce a graph that flags any deviation in the data of a given day from that cow's own daily averages over the last 10 d, as has been described previously (12).

Initially, the computer program was set up to identify daily those cows that during the previous day had recorded a reduction of at least 5% in their PA (≥ 5% fewer steps). This value was arbitrarily determined by the authors to eliminate the normal daily variations. Other possible indications for systemic diseases recorded by the computer were reduction of milk production and increased electrical conductivity of the milk. All cows with any indication of estrus, mastitis, or any other clinical systemic disease were excluded from the investigation.

During the study period, the cows that were diagnosed with clinical lameness by the herd staff and had no reduction in PA on the day of diagnosis were also investigated for possible association between the onset of lameness and reduction in PA in the 10 d preceding the appearance of the lameness.

False positive cases were defined as cows with PA reduction but no clinical lameness. False negative cases were defined as cows with clinical lameness but no PA reduction.

Clinical examinations

During the investigation, all cows identified by the computer as having 5% or greater reduction of their own PA average for the last 10 d were observed clinically for lameness by a senior bovine specialist (UB) and another clinician (HM or ST). The clinical examination included observation of gait, as well as palpation of suspected lame legs. Each leg suspected of lameness was further examined by lifting the foot and trimming the hoof. The clinically lame cows were treated until the lameness resolved, while the cows with a ≥ 5% reduction in PA were closely observed over the next 10 d for signs of clinical lameness.

In addition, all cows that were identified as lame cows by the herd staff were checked and treated, as described above. Although the cows were treated according to the cause of lameness, its etiology was not analyzed in this study. Each lame cow's PA was investigated only at the first onset of the lameness during the study period. Therefore, the design of the study excluded repeated PA analysis of the same cow.

Results

During the study period, 46 cows from the entire herd showed a reduction in PA. Twenty-one (45.7%) of these 46 cows developed clinical lameness in 7 to 10 d following detection of a reduction in PA and were defined as positive. In the other 25 (54.3%) cows, the reduction in PA was not followed by clinical lameness, mastitis, or other diseases, and they were defined as false positive cows. The graphical representation of PA reduction in a cow with a hoof abscess is shown in Figure 2.

The range of reduction in PA was from 9% to 68% (average, 38.5%). In 92% of the cows that developed clinical lameness, the decrease in PA was > 15%. The duration of reduced PA activity varied according to the specific lesion causing the lameness; it was not analyzed in this study.

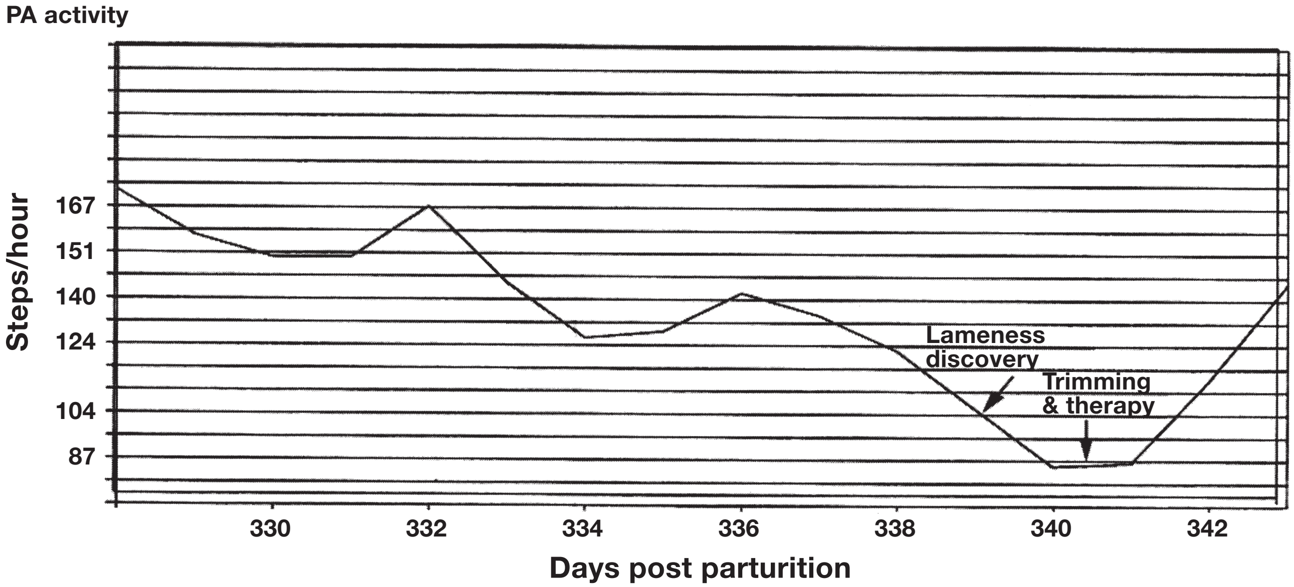

Figure 2. Graphic representation of PA reduction in a lame cow. The X axis represents the number of days postpartum. The Y axis represents the average number of steps per hour. Note the decline of the curve on day 332 postpartum until day 340 postpartum, when the hoof was treated. Note the increase of PA after treatment.

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During the study period, 38 cases of clinical lameness were recorded. Of these, 21 (55.3%) had a prior reduction in PA, and 17 (44.7%) did not, and were considered false negative cows.

Discussion

Many factors may affect the activity of the cow and cause a reduction in PA. These include changes in flooring and housing, and an increase in cow density in the barn or shed (2,3). Pain in the foot is among the major causes of decreased PA (10). Other possible causes of acute lameness included skidding on the slippery floors in the waiting shed of the milking parlor or in the yards, or the onset of "foot rot" (paronychia) and other sudden trauma (1).

Unlike the study of O'Callaghan (9), this study focused on the individual cow rather than on the entire herd. We assumed that by comparing a cow's PA with its own average of the previous 10 d, any sign of a specific reduction would immediately allow the cow to be examined for lameness.

Previous studies have shown that 80% to 95% of all dairy cattle lamenesses are caused by foot lesions (3); therefore, we predicted that cases of clinical lameness would be associated with a reduction in PA. But in this investigation, in 55.3% of lame cows, the approaching lameness could have been detected 7 to 10 d earlier by inspecting the list of exceptions in PA. Moreover, 45.7% of these reduced PA cases were due to clinical lameness.

A reduction in PA 3 d before diagnosis of metabolic illness in cows was recently reported (10). In another study, nearly 50% of subclinical mastitis cases were detected by PA (13). A possible explanation for the lack of reduction in PA in 44.7% of the lame cows in our study is that the computer calculated the average for the last 10 d on a daily basis based upon the manufacturer's recommendations. If the decrease of PA of the cow is slow and prolonged, it is possible that it may not be identified as a reduction. Thus, a 10 d average may be too short and it may be more precise to compare the cow's PA on a given day with the average of the last 20 or 30 d. Further studies are necessary to identify the optimal sampling procedure prior to the onset of clinical lameness. Moreover, if further research can establish a "normal PA" for the entire milking group, a comparison of a cow's specific day should be made with that value.

The relationship between sensitivity and percentage detection was reported in a previous study in which changing the threshold value improved the percentage detection of cows in estrus or with subclinical mastitis (13). In order to improve the percentage detection of lame cows by the pedometer, further studies are needed to develop more adequate calculation methods for analyzing the early changes in PA values. It may be recommended to set the PA reduction threshold to less than 5% in order to eliminate false positive cases. However, by increasing the sensitivity of the test, many false negative cows will be included, which will overload the management of the herd, and necessitates further research.

In this study, 92% of all lameness cases identified by the computer had a reduction of PA $>$ 15%. It is, therefore, unnecessary in practice to set the threshold of reporting reduction of PA below 15%, thereby reducing the number of the false negative lameness cases.

A pedometer is regularly used in the Tzora herd for detecting cows in estrus and mastitis. The investigation indicated that although PA did not detect all cases of developing lameness, the pedometer is a valuable tool for early discovery and treatment of developing foot lameness in about half the number of cases in a herd. Thus, in addition to the early discovery of metabolic disorders and estrus detection, the pedometer should be useful for detecting lameness (10,14). Further studies are needed to improve the capability of the pedometer to predict the onset of lameness.

Acknowledgments

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Book Review
Compte rendu de livre

BSAVA Manual of Canine and Feline Endocrinology, 3rd ed.

Mooney CT, Peterson ME, eds. BSAVA, Quedgeley, Gloucester, England, 2004, 240 pp., ISBN 0-905214-72-2, £75.00.

The *BSAVA Manual of Canine and Feline Endocrinology, 3rd edition* is a well written, easy to use textbook of the common endocrine disorders affecting dogs and cats. In the first 3 chapters, important practical aspects of sample collection and transport, the basic features of the commercially available hormone assays and the use of reference ranges and testing protocols are reviewed. Conversion tables between Système International (SI) units (used throughout the text) and conventional units are also provided. This normally hard-to-find information should be very useful to the busy practitioner. In addition to chapters describing the usual spectrum of specific endocrine diseases (canine diabetes mellitus, feline diabetes mellitus, canine hypothyroidism, canine hypoadrenocorticism, etc) there are chapters in which a practical diagnostic approach to problems such as polyuria/polydipsia, symmetrical alopecia, hypercalcemia and hypocalcemia, hyperlipidemia, and uncontrolled diabetes mellitus are outlined. There are also chapters in which some uncommon or "emerging" disorders such as acromegaly, feline hypoadrenocorticism, pheochromocytoma, autoimmune polyglandular disease, gastrinoma, and glucagonoma are discussed.

Contributing authors include established experts in the field from Europe, North America, and Australia, with 25 different authors for as many chapters. Unfortunately, as often happens with so many authors, the clarity of the writing, the level of detail, and the chapter organization is not uniform throughout the text. Some chapters are very practical, with specific recommendations for diagnostic testing and treatment, while others are more theoretical. The best, most practically focused chapters, in this reviewer's opinion, are those in which canine hypothyroidism, feline hyperthyroidism, canine diabetes mellitus, canine hyperadrenocorticism, and diabetic ketoacidosis are discussed. All of the chapters in the book, however, serve as useful, concise discussions of the topics assigned. All of the chapters contain new, up-to-date information on diagnosis and treatment, including the measurement of canine thyroid-stimulating hormone (TSH) for diagnosing hypothyroidism, the use of trilostane for treatment of canine hyperadrenocorticism, and the effect of hyperthyroid treatments on renal function. Considering the rate at which new advances in endocrinology seem to occur, this is a remarkably current text.

The color photographs, drawings, tables, and figures in this book are clear and complement the text. More photographs and radiographic images would be welcome in some of the chapters. In many of the chapters, specific cookbook-style recommendations for treatment are outlined in tables as well as discussed in the text, making them easy to follow and use.

In conclusion, this textbook meets the editor's stated goal of providing up-to-date information for veterinarians in practice, as well as for veterinary students, technicians, and nurses. The textbook is easy to use and enjoyable to read and would be a useful resource in any small animal practice.

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