Lameness in Dairy Cattle – New Research on Gait and Housing

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Abstract

This paper reviews recent research on lameness in dairy cows, with special focus on our work at the University of British Columbia addressing the scientific assessment of impaired gait, and how such impairments can be prevented through improvements in housing. Subjective gait scores can vary considerably between observers, but the reliability of these scores can be much improved with training and the use of well-defined scoring criteria. Some variation in gait relates to hoof pathologies and pain, factors typically considered central to the problem of cattle lameness. However, many cows with impaired gait have no visible sole lesions, and vice versa, and treating lame cows with analgesics has a significant but minor effect on gait. Gait also varies with features of the cow not related to lameness (e.g. udder fill) and with features of the environment (e.g. walking surface). Most importantly, lameness (as evidenced by impaired gait) can be dramatically reduced through improvements in housing conditions, including access to pasture or to more comfortable free stalls.

Keywords: lameness, gait, locomotion, pain, housing

Résumé

Cet article fait un survol des travaux récents sur la boiterie chez les vaches laitière et met l'accent principalement sur nos travaux à l'University of British Columbia qui portent sur l'évaluation scientifique de l'altération de la démarche et sur la prévention de telles déficiences par des améliorations au logement. Les scores subjectifs de démarche peuvent varier considérablement entre observateurs mais la fiabilité de ces scores s'améliore grandement avec l'entraînement et l'utilisation de critères de notation bien définis. Une source de variation dans la démarche peut être attribuée à des maladies de l'onglon et à la douleur; ces facteurs sont généralement considérés comme fondamentaux dans les problèmes de boiterie chez les bovins. Toutefois, plusieurs vaches avec une démarche altérée n'ont pas de lésions visibles à la sole et vice versa le traitement des vaches qui boitent avec des analgésiques a un effet significatif mais mineur sur la démarche. La démarche résulte aussi de facteurs qui ne sont pas reliés à la boiterie (e.g. le remplissage du pis) et varie selon le type d"environnement (e.g. la surface de déplacement). De façon plus importante, la boiterie (telle que mise en évidence par une démarche altérée) peut être réduite dramatiquement en améliorant les conditions de stabulation comme par exemple en permettant l'accès au pâturage ou en offrant des logettes plus confortables.

Introduction

This paper provides an overview of key research findings from our group at the University of British Columbia. This gives us the chance to highlight our own research and what we think are some particularly interesting and promising approaches to the growing problem of lameness in dairy cows.

We should begin by acknowledging our biases: we are students of animal behavior – ethologists – not veterinarians. This explains, no doubt, why we view lameness from the perspective of behavior (e.g. impaired gait) rather than other sorts of pathology (e.g. sole lesions).We are experimentalists, not epidemiologists; the work we review below has all the benefits of well-controlled, carefully manipulated systems, but also the limitations of work coming on a single (albeit excellent) research farm. Finally, our work is within UBC's Animal Welfare Program, with the mandate of improving the lives of animals through research, teaching and public outreach. Thus, our work on cattle lameness is focused on improving conditions for the cows, although we find the best way of achieving this goal is by showing practical benefits for the dairy farmer.

Below, we review our research on two areas: the scientific assessment of lameness, and the role of housing systems in lameness prevention. We hope to convince you that we have made some interesting progress in both areas. We consider the first area of basic importance (reviewed in detail by Flower & Weary)[7] as this helps pave the way for better research, and ultimately new discoveries in the science of cattle lameness. The latter area (reviewed in part by Weary and von Keyserlingk)[29] is of more practical importance, as it can lead to more immediate improvements in the lives of dairy cows.

Gait

We all agree on the bad cases – cows that can hardly move or just hobble on three legs are judged "lame" even by the neophyte. However, when we try to apply more sensitive assessments our judgments do not always match. It is now well recognized that individuals trained in dairy lameness pick up three to four times more cases of lameness than do the producers that own and care for these cows.[4,31]

Lameness researchers commonly use subjective observational methods to study the effect of hoof and leg pathologies on gait, most typically a numerical rating score (NRS). NRS rate cows for presence or absence of behaviors and postures related to gait.[17] For example, Sprecher *et al*[22] describe a system that focuses on the extent of back arch when standing and walking. The reliability of a gait score is the extent to which it can be measured precisely and consistently. Experience is important; for example, Main *et al*[16] showed that the NRS scores of experienced and inexperienced observers agreed only 26 - 53% of the time, but experienced observers showed 94% agreement. The specificity of the scoring systems is also important; imprecise language used to described categories allows more leeway among observers. For example, when Garner *et al*[12] introduced more specific category description into an older lameness scoring system, the within-observer consistency improved from r = 0.72 to 0.95.

NRS rely on an overall evaluation of the animal, typically based on several behaviors. When specific behaviors such as head bob, back arch, tracking-up, joint flexion, asymmetric gait and reluctance to bear weight were scored separately using a visual analogue scale, some could be scored consistently (e.g. tracking-up) but not others (e.g. joint flexion); however, for all measures agreement was best for the higher scores.[8]

More recent work on dairy cattle has also shown that with experience, observers were more likely to agree.[2,18] Readers should not be lulled into thinking that these issues of reliability just affect gait score; poor reliability is also an issue for hoof scores and indeed all subjective clinical measures. For example, Holzhauer *et al*[15] found that trimmers varied greatly in scores for digital dermatitis, heel erosion and sole lesions.

Problems of reliability can be avoided by using objective measures. A number of approaches have been applied to the objective assessment of lameness in cattle. For example, Rajkondawar *et al*[20] used a system of force plates to determine how cows distributed their weight while walking, assuming that lame cows do not distribute their weight evenly among the four limbs.

Even when a gait attribute can be measured with perfect reliability, it will only be useful if it relates in some meaningful way to the problems at the core of concern; typically hoof and leg injuries, and the pain that animals experience while walking. Unfortunately, very little research to date has validated gait measures against more direct assessments of pain or injury. One approach to validating scoring systems is to compare gait in animals with and without known hoof and leg pathologies; unfortunately, this relationship is often weak. For example, the presence of sole lesions accounts for just 20 - 70% of the variation in gait scores.[30] Despite their better reliability, we have found that objective measures of gait are no more valid as predictor of injuries; in one study we found that kinematic measures could identify cows with sole ulcers,[6] but we could not replicate this finding in a second study.[5]

In some cases at least, cows modify their gait to reduce the pain associated with walking. Unfortunately, little is known about the role of pain in gait, and almost no research has examined what ailments commonly associated with lameness are painful. One way of examining the role of pain is compare responses with and without treatment using analgesics. Two recent studies have used this approach: Rushen *et al*[21] found modest improvements in gait scores of lame cows when they were provided a local anesthetic, and Flower *et al*[10] found a small but significant dose-dependent improvement in gait with analgesic treatment.

One complication of using altered gait as an indicator of pain and injury is that cows may also change their gait in response to mechanical and environmental influences. For example, Flower *et al*[9] found that cows walked faster and had longer strides when returning from the parlor, perhaps because they were less obstructed by an engorged udder. Flooring surface also affects gait: dairy cows walking on low friction surfaces take more frequent and short strides compared to walking on higher friction surfaces.[19] Flower *et al*[5] also found that cow gait improved on a soft, higher friction rubber surface in comparison to concrete, particularly for cows with higher gait scores.

In summary, subjective and objective gait measures can be scored reliably, although the reliability of the subjective assessments is greatly improved through the use of more specific descriptions and observer training. A number of scientific approaches are available to validate gait measures, and some measures have been demonstrated to be useful predictors of hoof injuries and pain cows experience while walking. However, many gait measures remain un-validated, and much of the variance in validated measures is due to factors other than pain or injuries, such as the walking surface. A goal for future research is to develop gait assessment tools that can more accurately identify animals with painful injuries. Improved gait assessment methods will, we believe, pave the way for better research and ultimately new discoveries in the science of cattle lameness, such

as how changes in housing systems can reduce the risk of animals becoming lame, as reviewed in the next section.

Housing and Lameness

Despite the importance of lameness to the dairy industry and the quantity of research that has been devoted to this topic, there has been little experimental research testing how changes in the way cows are housed and managed can reduce the risk of lameness, as evidence by impaired gait.

Understanding the effects of housing for dairy cows on behavior and health has been a major focus for our research. We have worked on how variation in bedding, stall design, flooring and the feeding area can improve cow comfort and avoid injuries. For example, our group was the first to show that bedding and stall surface are key determinants of hock injuries,[23] and how these injuries can be prevented by manipulating these features.[13]

Our work has also shown that the surface provided for cows is one of the most important factors in designing a suitable lying area.[11,26] Cows clearly prefer lying surfaces with more bedding, and spend more time lying down in well-bedded stalls.[3,24] However, most indoor housing provides more than just a lying surface for cows. Typically, the space is designed to encourage the cow to lie down in a specific location, such that feces and urine do not soil the stall. Substantial work has addressed the effects of stall size and bedding but less work has looked at stall architecture. Despite the expense associated with installing stall partitions and other hardware used to configure free stalls, our work to date has shown that these structures seem to reduce cow comfort and stall use,[27] and other research has shown that the incidence of lameness is higher in free stall housing.

More open bedded areas require regular maintenance to keep clean, but the extra effort may be warranted if the housing provides major benefits in terms of comfort and reduced lameness. Our recent research has shown that lameness may be treated by temporarily placing cows in more comfortable surroundings. For example, Hernandez-Mendo *et al*[14] showed that just four weeks on pasture led to improvements in gait of previously lame cattle, but control cows that stayed in a free stall barn showed no such improvement. These results correspond well with earlier studies focused on injuries associated with lameness, but our results show just how quickly gait improves when cows have access to pasture. The improvement in gait was not due to increased lying times – cows on pasture actually spent less time lying down. We believe that the gait improvement was due to cows spending less time standing in slurry and on the wet concrete found inside the free stall barn.

Providing even temporary access to pasture can be a challenge for some producers, so indoor systems that provide similar advantages are required. Given that our results and others point to standing outside of the stall (typically on wet concrete) as being the heart of the problem, we tested the effects of a stall design feature known to affect this behavior – neck rail position. Free stalls are typically configured with a neck rail that prevents cows from standing fully in the stall, with the intention of preventing feces and urine from contaminating the stall and ultimately improving udder health. However, both the height of the neck rail and its distance from the curb affect standing; more restrictive neck-rail placements (lower and closer to the rear of the stall) prevent cows from standing fully in the stall.[27] Thus, designing stalls that stay clean has the unintended effect of increasing standing time outside of the stall, likely increasing the risks of lameness and hoof disease.

We tested this association in a recent experiment [1] by housing cows in pens with and without neck rails using a crossover design. When provided stalls without neck rails, the cows spent more time standing with all four hooves in the stall and less time 'perching' with just the front two hooves in the stall. As predicted, this change in behavior resulted in a change in lameness – when cows were housed without neck rails, gait improved and cows were much less likely to become lame; 13 new cases of lameness developed during the 10-week experiment, but only two of these occurred while cows were in pens without neck rails. Also as predicted, stalls without neck rails were more likely to be contaminated with fecal matter and urine, although this did not result in an increased risk of clinical or sub-clinical intra-mammary infection.

This study provides the first experimental evidence that aspects of stall design can reduce the risk of lameness, and illustrates that changes in design that result in improvements in cow comfort and lameness can come at the expense of cow and stall cleanliness. From our perspective, the benefits far exceed the costs associated with stall maintenance. However, a better option would be housing that keeps cows clean and reduces the risk of lameness. Well-managed pasture can do just this, but many dairy producers also require indoor housing. We urge new research on housing systems that provide both a suitable environment for the cow to stand (thus reducing the risk of lameness), and a clean, dry lying surface that promotes cow comfort and udder health (thus reducing the risk of mastitis).

Acknowledgements

We are grateful to our colleagues within UBC Animal Welfare Program for years of help and advice in the work described above. We also thank supporters of the

Program including the Natural Sciences and Engineering Research Council of Canada, the Dairy Farmers of Canada, and many others listed at http://www.landfood.ubc.ca/animalwelfare/.

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