Using Cow Behaviour to Predict Disease

Marina A. G. von Keyserlingk, Katy L. Proudfoot, Lori Vickers and Daniel M. Weary

Animal Welfare Program, University of British Columbia, Vancouver BC V6T 1Z6
Email: marina.vonkeyserlingk@ubc.ca

Take Home Messages

- Postpartum disease and lameness in dairy cows have implications for animal welfare, long-term milk production, reproductive health, and risk of culling. Despite decades of research, the incidence of these diseases remains unacceptably high.
- Changes in behaviour during transition can predict disease and lameness risk post partum.
- Management practices can alter transition cow behaviour during. The transition cow environment should include low competition for feed, comfortable, clean, and dry spaces for lying and standing, and minimal social regroupings.

Introduction

A major challenge for dairy producers and veterinarians is to maintain healthy dairy cows. Dairy cows are most likely to become ill during the transition period around calving (i.e., 3 wk before to 3 wk after calving). These illnesses include metabolic diseases such as hypocalcaemia and ketosis, infectious diseases such as mastitis and metritis, and diseases in the hoof and leg that cause lameness. These diseases are costly to the producer and cause poor welfare for the afflicted cow; thus they are of high relevance to the dairy industry (von Keyserlingk et al., 2009).

Most postpartum diseases do not have a single cause, and often do not occur in isolation. For instance, many infectious diseases diagnosed during transition occur as a secondary illness to metabolic diseases such as ketosis or hypocalcemia. Healthy metabolism during the transition period is influenced by nutrition and feed intake, both of which can also affect immunity (Goff, 2006). It has been suggested that animals that experience moderate metabolic stress after calving might sacrifice immune function for the sake of maintaining lactation, a considerably more important function at that time.

Veterinary examination of post-partum cows is relatively infrequent on most farms (commonly once every two weeks). Thus, many cases of transition period disease may go unnoticed. Producers can use urine or milk tests to monitor the health of their animals, but frequent administration of tests on a herd-wide scale can be costly and time-consuming. Moreover, no such tests are available for diagnosing inflammatory uterine disease (metritis or endometritis), one of the most common disorders after calving. The common practice of using daily milk yield as a general indicator of animal health or welfare is a relatively insensitive method for identifying sick or at-risk animals (reviewed by von Keyserlingk et al., 2009). Thus, a more sensitive method of continuously monitoring animal health or risk for disease during the transition period is needed.

■ Behaviours Can Predict Disease And Lameness

Dairy cows face numerous management challenges during the transition period. On typical North American dairy farms the transition from pregnancy to lactation is marked by several social re-groupings and changes in diet. The first group change, approximately 3 wks before the cow's expected calving date, allows cows to be fed a diet with the higher energy and nutrient levels required for parturition and lactation. This occurs so that producers can closely monitor the cows as they approach their expected calving date. There is evidence, however, that regrouping has negative consequences on both behaviour and production. Recent work by our own group showed decreased rumination in prepartum cows in the days following regrouping. The greatest of these effects were for cows that were moved to a new group (Schirmann et al., submitted). Other work has also shown increased aggression and reduced milk production in the days immediately following regrouping in mid lactation cows (von Keyserlingk et al. 2008).

As parturition approaches, cows are moved to a maternity pen where they are usually isolated from the herd. Social isolation in unfamiliar surroundings may be stressful, particularly for primiparous cows that are experiencing this move for the first time (Rushen et al., 1999). After calving, the calf is removed and the cow is moved to the lactating herd and is fed a new diet formulated to provide more energy to support the increased nutrient demands for lactation.

Some cows are able to cope with these challenges better than others. Cows that become ill after calving likely behave differently in response to these challenges compared to cows that remain healthy. To determine if these differences exist, we first documented the behaviour of 15 healthy cows from 10 d before until 10 d after calving (Huzzey et al., 2005). These cows spent on average about 86.8 ± 2.95 min/d feeding during the precalving period. Cows reduced feeding time by about one hour a day after calving, but increased by about 3 min each day thereafter for the duration of the study period. Lower feeding times after calving may be explained by an increased

feeding rate due to the switch to a higher energy diet immediately after calving. The small daily increase in feeding time post partum most likely reflects the rapid increase in dry matter intake that occurs during this period.

Healthy cows stood on average for 12.3 and 13.4 h/d during the pre and post partum period, which is not much different than during other stages of lactation. There was a dramatic increase (80%) in the number of standing bouts from 2 days before calving to the day of calving (Huzzey et al. 2005). This result suggests that cows were more restless, likely due to the discomfort associated with calving, and suggests that special attention should be placed on cow comfort in the maternity pen. This may be particularly important for cows experiencing dystocia (Proudfoot et al., 2009b).

Metritis is an important post-partum disease due to its negative effects on the reproductive performance of dairy cows. The incidence of metritis or endometritis varies among studies from 8 to 53% (7.6%, Grohn et al. 1995; 53%, Gilbert et al. 2005; 16.9%, LeBlanc et al. 2002). This variation is likely due to differences in the diagnostic methods used to classify uterine infections. On the average dairy farm disease detection is done by the veterinarian, but typically only during routine herd health checks, so in many cases early warning signs of disease go unnoticed until such time that the disease is in its clinical stage.

In two studies we assessed whether cows that became ill with metritis after calving behaved differently than healthy cows. In the first study, we followed 6 Holstein heifers and 20 Holstein cows housed in a free-stall barn, and divided them into a pre-partum and post-partum group. Although group size was kept constant, group composition was dynamic as animals moved between pens as they progressed though the transition period, as is typical of many commercial situations. An electronic feeder was used to continuously monitor the feeding behaviour of individual cows over the course of the study, and this data was used to estimate average daily feeding time. After calving the cows were examined for metritis every 3 ± 1 d, based on rectal body temperature and condition of vaginal discharge. Vaginal discharge (VD) was assigned a score from 0 - 4 based on a scale adapted from Dohmen et al. (1995). As there is disagreement in the literature concerning which diagnosis criteria constitutes a case of metritis, 2 classifications were employed. Animals were classified as metritic if they showed a VD ≥ 2 plus fever (≥ 39.5˚C within 3 d before observation of VD ≥ 2) or acutely metritic if they showed a VD=4 plus fever (Urton et al., 2005).

Of the 26 cows used in this study 18 cows (69%) experienced some degree of pathological discharge (VD≥2) with a range of onset from 3-15 DIM. When we compared the feeding time of these cows beginning 2 weeks before calving, there were clear differences. Cows diagnosed with metritis/acute metritis spent less time feeding during both the pre- and post-calving period

compared to healthy cows.

In a follow-up study, Huzzey et al. (2007) recorded the dry matter intake (DMI) of 101 cows from 14 days before calving to 21 days after calving. Cows that developed metritis or acute metritis ate less than healthy cows in the pre-partum period, up to 3 weeks before the disease was diagnosed. Feeding time was also measured and showed the same pattern. With every 10 minute decline in feeding time in the pre-partum period, the odds of cows becoming ill doubled. Social behaviour in the pre-partum period was measured, as this is likely influenced by the many challenges during transition. Cows that developed post-partum metritis also engaged in fewer aggressive interactions at the feed bunk during the week prior to calving and avoided the feed bunk during periods when competition for feed is highest. Moreover, cows that became ill with sub clinical and clinical metritis produced less milk during the first 28 weeks of lactation.

Long-term costs of metritis are often more difficult to quantify than short-term costs, yet may be much greater, such as heavy milk losses, poor reproductive performance, and potentially culling the animal. A recent short communication from our research group has estimated that cows with postpartum metritis produced less milk than healthy cows up to 20 wk into lactation, and cows that lasted 305 d lost about 1200 kg of milk over their lactation (Wittrock et al., in press). Cows in this study with postpartum metritis were also twice as likely to be culled – probably as a combination of having lower milk yields as well as poor reproductive performance, since these are two of the most important factors that influence the decision to cull a cow.

Feeding behaviour can also predict metabolic disease. In a follow-up study to the metritis work, Goldhawk et al. (2009) found that cows with low pre-partum intakes were more at-risk for subclinical ketosis after calving. Cows that later developed ketosis ate less, spent less time eating and were less likely to be socially engaged at the feedbunk up to 2 weeks before calving.

Aside from the work we have undertaken on metritis and subclinical ketosis, we have also been interested in identifying risk factors that identify cows at risk for lameness. Historically, lameness has not been thought of as a transition cow disease, likely because most cases of lameness arise months into lactation. Recent work has provided evidence that physiological and behavioural changes during transition can increase the risk of lameness later in lactation (Knott et al., 2007; Cook and Nordlund, 2009; Proudfoot et al., 2010). Many severe cases of lameness are caused by claw horn lesions (e.g., sole ulcers and white line lesions), which take 8 to 12 weeks to develop. Thus, a sole ulcer that is diagnosed 12 wk after calving likely began developing, or was triggered, during transition. The high incidence of lameness cases after calving illustrates the need to focus on the transition period to prevent both infectious and metabolic diseases directly after calving,

as well as lameness cases months after calving.

In a very recent study we assessed whether transition cows at risk for lameness behaved differently than healthy cows (Proudfoot et al., 2010). Data loggers were fixed to the hind legs of cows and measured standing time 2 weeks before to 3 weeks after calving. Cows were then hoof scored monthly until 15 weeks in milk. Thirteen cows developed sole ulcers or severe sole haemorrhages between 7 and 15 weeks after calving. The standing behaviour during transition of these cows was compared to 13 healthy cows. Cows with lameness after calving stood longer in the pre- and early post-partum period than healthy cows. Most of this difference was driven by higher time spent half in the stall (i.e., "perching" with the 2 front feed in the stall and 2 hind feet in the alley).

Ample evidence now suggests that detailed knowledge of behaviour can help identify cows at risk for metritis, sub clinical ketosis and lameness in transition dairy cows. This information can also guide the development of management practices that can 1) help detect disease early and 2) help prevent disease by addressing management challenges during transition that might influence these risky behaviours (i.e., decrease feed intake and increase standing time).

■ Diet, Behaviour and Disease

One main challenge for the transition cow is the sudden increase in nutrient requirement to support lactation at a time when DMI and nutrient supply begin to decline (Drackley, 1999). Low DMI pre-calving is a predictor of metritis after calving, thus to improve transition success, we must either decrease the nutrient demand on the cow or increase her nutrient intake (Grummer et al., 2004). This idea has led to feeding steam-up diets pre-calving formulated with higher nutrient densities to ensure cows are consuming sufficient energy (Eastridge, 2006). However, the experimental work using this type of diet has not shown any advantage in terms of cow health.

There has been recent agreement that the importance of nutrition for the dry cow begins at the onset of dry off. Far off cows have been shown to over consume DM by as much as 60% of their daily requirements if fed ad libitum (Dann et al., 2006). Excess energy is stored in the liver and is linked to greater incidents of health problems (Drackley, 1999). Cows overfed in the dry period had higher BHBA and NEFA levels and a lower energy balance at the onset of lactation, suggesting an increased risk for developing ketosis and other health issues (Dann et al., 2006). Cows fed high energy diets prepartum demonstrate higher DMI, energy intake and energy balance; however, they also had more drastic declines in DMI as parturition approached (Rabelo et al., 2003).

There is growing support that restricting DMI in the dry period allows cows to increase DMI immediately postpartum, resulting in higher energy balances, and lower NEFA and BHBA concentrations (Dann et al., 2006). In addition, lower energy intake during the dry period improved post calving appetites and lowered body fat mobilization (Douglas et al., 2006). Preliminary results from our work showed that cows fed higher forage diets prepartum have higher DMI as calving approaches. Cows fed high forage diets also had lower postpartum BHBA and subclinical ketosis (Vickers et al., 2010).

■ Accommodating The Vulnerable Transition Cow

A number of management practices can influence the feeding and standing behaviour of transition dairy cows. For instance, overstocking the feed bunk increases standing time waiting to gain access to the feed bunk (Huzzey et al. 2006), reduces the amount of time cows spend feeding, and reduces intake in healthy transition cows (Proudfoot et al., 2009a). When cows are given generous space to feed, subordinate animals are most likely to benefit (DeVries et al., 2004). Grouping strategy may also influence feeding behaviour; regrouping or mixing cows into new social groups can decrease feed intake as well as the number of aggressive interactions in which the new cow is involved (von Keyserlingk et al., 2008). Stimulating feeding can be done using a frequent delivery of fresh feed (DeVries et al., 2005); cows fed 4 times per day spend about 30 min more time eating than cows fed once per day.

A high standing time could suggest a deficit in the cow's environment; for instance, cows housed in pens with insufficient number of lying stalls, low bedding, wet bedding, or restrictive neck rails spend more time standing than those with dry stalls and less restrictive neckrails (Tucker and Weary, 2004; Fregonesi et al., 2007; Fregonesi et al., 2009). Cows that perch with their 2 front feet in the stall during transition are also at increased risk for lameness (Proudfoot et al., 2010); this behaviour has been linked with restrictive stall design (Tucker et al., 2005; Fregonesi et al., 2009).

Moving the neckrail further from the curb reduces perching behaviour and can reduce lameness cases (Bernardi et al., 2007). Although this practice comes at a hygiene cost (cows standing with all 4 feet in the stall will defecate and urinate more into the stall) there is no clear evidence that it increases the risk of mastitis. However, if this practice is utilized after calving, it is recommended that stalls be cleaned often, as fresh cows are at high risk for mastitis.

■ Conclusions

Transition cows need adequate rest, appropriate nutrient intake, and a relatively stable social environment to stay healthy. Some risk factors for

infectious and metabolic diseases postpartum and lameness in the few months after calving are related to housing and management. An optimal transition cow environment facilitates ample feed intake by reducing competition for feed and social regrouping, as well as accommodates these vulnerable cows with clean, dry, well-bedded, and unrestrictive standing and lying spaces.

Acknowledgements

We thank the staff and students of the University of British Columbia's Animal Welfare Program. The Animal Welfare Program is supported, in part, by Canada's Natural Sciences and Engineering Research Council Industrial Research Chair Program (Ottawa, ON, Canada) with contributions from the Dairy Farmers of Canada, Westgen, Pfizer Animal Health, BC Cattle Industry Development Fund, the BC Milk Producers, BC Dairy Foundation, BC Dairy Industry Research and Education Fund, Alberta Milk. many others listed on the Animal Welfare web site at http://www.landfood.ubc.ca/animalwelfare.

References

Bernardi, F., J. Fregonosi, D.M. Veira, C. Winkler, M.A.G. von Keyserlingk, and D.M. Weary. 2009. The stall design paradox: neck rails increase lameness but improve udder and stall hygiene. J. Dairy Sci. 92:3074-3080.

Cook, N. B., and K. V. Nordlund. 2009. The influence of the environment on dairy cow behaviour, claw health and herd lameness dynamics. Vet. J. 179:360-369.

Dann, H. M., N. B. Litherland, J. P. Underwood, M. Bionaz, A. D'Angelo, J. W. McFadden, and J. K. Drackley. 2006. Diets during far-off and close-up dry periods affect periparturient metabolism and lactation in multiparous cows. J. Dairy Sci. 89:3563-3577

DeVries, T. J., M. A. G. von Keyserlingk, and D. M. Weary. 2004. Effect of feeding space on the inter-cow distance, aggression, and feeding behavior of free-stall housed lactating dairy cows. J. Dairy Sci. 87:1432-1438.

DeVries, T. J., M. A. G. von Keyserlingk, and K. A. Beauchemin. 2005. Frequency of feed delivery affects the behavior of lactating dairy cows. J. Dairy Sci. 88:3553–3562.

Douglas, G. N., T. R. Overton, H. G. Bateman, H. M. Dann, and J. K. Drackley. 2006. Prepartal plane of nutrition, regardless of dietary energy source, affects periparturient metabolism and dry matter intake in Holstein cows. J. Dairy Sci. 89:2141-2157.

Dohmen, M.J.W., J.A.C.M. Lohuis, G. Huszenicza, P. Nagy and M. Gacs. 1995. The relationship between bacteriological and clinical findings in cows with subacute/chronic endometritis. Theriogenology 43:1379-1388.

Drackley, J. K. 1999. Biology of Dairy Cows During the Transition Period: the Final Frontier? J. Dairy Sci. 82:2259-2273.

Eastridge, M.L. 2006. Major Scientific Advances in Dairy Science During the Last 25 Years: Major advances in applied dairy nutrition. J. Dairy Sci. 89:1311-1323.

Fregonesi, J. A., D. M. Veira, M. A. G. von Keyserlingk, and D. M. Weary. 2007. Effects of bedding quality on lying behavior of dairy cows. J. Dairy Sci. 90:5468-5472.

Fregonesi, J. A., M. A. G. von Keyserlingk, C.B. Tucker, D.M. Veira, and D.M. Weary. 2009. Neck-rail position in the freestall affects standing behavior, udder and stall cleanliness. J. Dairy Sci. 92:1979–1985.

Gilbert, R.O., S.T. Shin, C.L. Guard, H.N. Erb and M. Frajblat. 2005. Prevalence on endometritis and its effects on reproductive performance of dairy cows. Theriogen. 64:1879-1888.

Goff, J. P. 2006. Major advances in our understanding of nutritional influences on bovine health. J. Dairy Sci. 89:1292-1301.

Grohn, Y.T., S.W. Eicker, J.A. Hertl. 1995. The association between previous 305-day milk yield and disease in New York State dairy cows. J. Dairy Sci. 78:1693-1702.

Grummer, R. R., D. G. Mashek, and A. Hayirli. 2004. Dry matter intake and energy balance in the transition period. The Vet. Clinics of North America. Food Animal Practice 20:25.

Goldhawk, C., N. Chapinal, D.M. Veira, D.M. Weary, and M.A.G. von Keyserlingk. 2009. Prepartum feeding behavior is an early indicator of subclinical ketosis. J. Dairy Sci. 92:4971-4977.

Huzzey, J. M., M. A. G. von Keyserlingk and D. M. Weary. 2005. Changes in feeding, drinking, and standing behavior of dairy cows during the transition period. J. Dairy Sci. 88:2454-2461.

Huzzey, J. M., T. J. DeVries, P. Valois, and M. A. G. von Keyserlingk. 2006. Stocking density and feed barrier design affect the feeding and social behavior of dairy cattle. J. Dairy Sci. 89: 126-133.

Huzzey, J. M., D. M. Veira, D. M. Weary, and M. A. G. von Keyserlingk. 2007. Prepartum behavior and dry matter intake identify dairy cows at risk for metritis. J. Dairy Sci. 90:3220-3233.

Knott, L., J. F. Tartlon, H. Craft, and A. J. F. Webster. 2007. Effects of housing, parturition and diet change on the biochemistry and biomechanics of the support structures of the hoof of dairy heifers. Vet. J. 174:227-287.

LeBlanc, S. J., T. F. Duffield, K. E. Leslie, K. G. Bateman, G. P. Keefe, J. S. Walton, and W. H. Johnson. 2002. Defining and diagnosing postpartum clinical endometritis and its impact on reproductive performance in dairy cows. J. Dairy Sci. 85:2223-2236.

Proudfoot, K.L., D.M. Veira, D.M. Weary, and M.A.G. von Keyserlingk. 2009a. Competition at the feed bunk changes the feeding, standing, and social behavior of transition dairy cows. J. Dairy Sci. 92:3116-3123.

Proudfoot, K.L., J.M. Huzzey, and M.A.G. von Keyserlingk. 2009b. The effect of dystocia on the dry matter intake and behavior of Holstein cows. J. Dairy Sci. 92:4937-4944.

Proudfoot, K.L., D.M. Weary, and M.A.G. von Keyserlingk. 2010. Behavior during transition differs for cows diagnosed with claw horn lesions in mid lactation. J. Dairy Sci. 93:3970-3978.

Rabelo, E., R. L. Rezende, S. J. Bertics, and R. R. Grummer. 2003. Effects of transition diets varying in dietary energy density on lactation performance and ruminal parameters of dairy cows. J. Dairy Sci. 86:916-925.

Rushen, J., A. Boissy, E.M.C. Terlouw, A.M.B. de Passillé, 1999. Opiod peptides and behavioral and physiological responses of dairy cows to social isolation in unfamiliar surroundings. J. Anim. Sci. 77:2918-2924.

Tucker, C. B., D. M. Weary, and D. Fraser. 2005. Neck-rail placement: effect on freestall preference, usage, and cleanliness. J. Dairy Sci. 88:2730-2737.

Tucker, C. B., and D. M. Weary. 2004. Bedding on geotextile mattresses: how much is needed to improve cow comfort? J. Dairy Sci. 87:2889-2895.

Urton, G., M.A.G. von Keyserlingk and D.M. Weary. 2005. Feeding behaviour identifies dairy cows at risk for metritis. J. Dairy Sci. 88:2843-2849.

Vickers, L.A., D.M. Weary, D.M. Veira and M.A.G. von Keyserlingk. Effects of a low energy diet prepartum on subclinical ketosis in dairy cattle. Abstract presented at the ADSA/CSAS/ASAS Joint Annual Meeting, Denver, USA, 2010.

von Keyserlingk, M.A.G., J. Rushen, A.M.B. de Passillé and D.M. Weary. 2009. INVITED REVIEW: The Welfare of Dairy Cattle – Key Concepts and the Role of Science. J. Dairy Sci. 92: 4101-4111.

von Keyserlingk, M. A. G., D. Olineck, and D. M. Weary. 2008. Acute behavioral effects of regrouping dairy cows. J. Dairy Sci. 91:1011-1016.

Wittrock, J. M., K. L. Proudfoot, D. M. Weary, and M. A. G. von Keyserlingk. In press. Metritis affects long-term milk production and cull rate of Holstein dairy cows. J. Dairy Sci.