J. Dairy Sci. 96:7066–7072
http://dx.doi.org/10.3168/jds.2013-6967

Short communication: Herd-level reproductive performance and its relationship with lameness and leg injuries in freestall dairy herds in the northeastern United States

N. Chapinal,* M. A. G. von Keyserlingk,* R. L. A. Cerri,† K. Ito,*‡ S. J. LeBlanc,§ and D. M. Weary*[1]
*Animal Welfare Program, University of British Columbia, Vancouver, BC V6T 1Z4, Canada
†Faculty of Land and Food Systems, University of British Columbia, Vancouver, BC V6T 1Z4, Canada
‡Novus International Inc., St. Charles, MO 63304
§Population Medicine, University of Guelph, Guelph, ON N1G 2W1, Canada

ABSTRACT

The objectives of this study were to describe herd-level reproductive outcomes and their associations with the prevalence of lameness, hock injuries and knee injuries in freestall dairy herds in the northeastern United States. Five reproductive outcomes (calving to conception interval, CCI; calving interval, CI; conception risk at the first artificial insemination, CR1; insemination rate, IR; and pregnancy rate, PR) were measured from Dairy Comp 305 (Valley Agricultural Software, Tulare, CA) for a 12-mo period for all multiparous cows in each of the 53 herds assessed. The prevalence of lameness, hock injuries, and knee injuries was assessed in 1 high-producing group. The means (± standard deviation) for the 5 reproductive outcomes were as follows: CCI = 128 ± 10 d, CI = 404 ± 10 d, CR1 = 36 ± 5%, IR = 60 ± 7%, and PR = 20 ± 3%. The average prevalence of clinical lameness, hock injuries, and knee injuries were 45 ± 20%, 58 ± 31%, and 16 ± 15%, respectively. Univariable associations between the reproductive outcomes and the prevalence of lameness and leg injuries were tested and significant predictors were submitted to a model that controlled for the confounding effects of herd size, 305-d mature equivalent milk production of the high-producing group, and use of deep bedding. A higher prevalence of lameness was associated with poorer reproductive performance, although the relationships were weak: herds with a higher prevalence of lameness had longer average CCI (slope estimate = 0.16 ± 0.07; R^2 = 0.09) and CI (slope estimate = 0.14 ± 0.07; R^2 = 0.07). These results indicate that management to reduce lameness may improve reproductive performance.

Key words: cow comfort, fertility, gait, skin lesion

Short Communication

Infertility and lameness are two of the most serious problems in modern dairy herds. The prevalence of lameness has increased worldwide (Espejo et al., 2006; Dippel et al., 2009; von Keyserlingk et al., 2012) while reproductive performance has gradually declined (Washburn et al., 2002; VanRaden et al., 2004; Norman et al., 2009). Some of the economic losses associated with lameness are thought to be due to effects on fertility (Garbarino et al., 2004; Bicalho et al., 2007). The relationship between lameness and reproduction has been studied at the cow level. Lameness after calving has been associated with delayed cyclicity (Garbarino et al., 2004), higher incidence of ovarian cysts and lower pregnancy to first AI (Melendez et al., 2003), and longer intervals from calving to first AI and to conception (calving to conception interval, **CCI**) (Sprecher et al., 1997; Hernandez et al., 2005; Bicalho et al., 2007). Pain associated with lameness alters behavior, weakening the expression of estrus (Walker et al., 2010) and reducing feed intake (González et al., 2008), both of which may lower reproductive performance. Hock and knee injuries are also common in modern dairy herds (Kielland et al., 2009; Lombard et al., 2010; von Keyserlingk et al., 2012). These injuries may also alter cows' behavior and affect reproduction in a similar way to lameness; however, to our knowledge, no previous research has examined these linkages.

The effect of lameness and leg injuries on reproduction may vary from cow to cow, but these problems are typically managed at the herd level. Reproductive performance is also typically assessed with herd-level measures such as conception risk (**CR**), insemination rate (**IR**; formerly known as heat detection rate), and pregnancy rate (**PR**). Insemination rate and PR include all the cows in the herd that are eligible to be bred, as opposed to measures such as average CCI or calving interval (**CI**), which exclude cows that fail to become pregnant. Pregnancy rate is determined by CR and IR (with many variables in turn influencing

Received April 26, 2013.
Accepted August 5, 2013.
[1]Corresponding author: dan.weary@ubc.ca

each of these measures); thus, PR is likely the most comprehensive single measure to assess herd reproductive performance. To the best of our knowledge, the relationship between herd-level reproductive outcomes and the prevalence of lameness, hock injuries, and knee injuries has not been studied.

The objective of this study was to investigate the associations between herd-level reproductive outcomes and the prevalence of lameness, hock injuries, and knee injuries in freestall dairy herds in the northeastern United States, a region known to suffer high rates of lameness and leg injuries (von Keyserlingk et al., 2012). In this study, we focused on multiparous cows, because this group of animals is most likely to experience lameness (Offer et al., 2000; Chapinal et al., 2010), leg injuries (Rutherford et al., 2008; Kielland et al., 2009), and infertility (Chebel et al., 2004; Santos et al., 2009). A second objective was to describe the reproductive performance of freestall dairy herds in this region.

A total of 53 herds in the northeastern United States (Connecticut n = 1; New York n = 48; Pennsylvania n = 1; Vermont n = 3) were selected from within the Novus C.O.W.S. program, a partnership between The University of British Columbia and Novus International Inc. (http://www.novusint.com/en/Market-Segments/Dairy/COWS), for this observational study. All herds meeting the following inclusion criteria were included in the study: Holstein cows, freestall housing, feeding a TMR, and use of the herd management software Dairy Comp 305 (Valley Ag Software, Tulare, CA). The mean (±SD) herd size was 863 ± 488 milking cows and the mean 305-d mature-equivalent milk production was 12,278 ± 873 kg. All methods used to collect data were approved by the University of British Columbia's Animal Care Committee, which follows the standards outlined by the CCAC (2009).

Herds were visited between July 2010 and July 2012. In each herd, the manager selected a "high-producing" pen of primarily multiparous cows (mean ± SD group size = 172 ± 77 cows; lactation number = 2.9 ± 0.4; DIM = 148 ± 46 d; 305-d mature-equivalent milk production = 12,177 ± 950 kg) for assessing lameness and leg injuries. The first 25 of the 53 herds assessed were also included in von Keyserlingk et al. (2012), Barrientos et al. (2013), and Chapinal et al. (2013), but none of those papers reported reproductive outcomes.

All cows housed in the high-producing pen were gait scored as they exited the parlor using a 5-point Numerical Rating System (**NRS**), where 1 = sound and 5 = severely lame (Flower and Weary, 2006; Chapinal et al., 2009). Cows with NRS ≥3 were considered clinically lame, and cows with NRS ≥4 were considered severely lame. A total of 9,103 cows were scored. The percentage of clinically and severely lame cows was calculated for each herd.

A sample of 38 to 40 primarily multiparous focal cows (mean ± SD lactation number = 2.8 ± 0.4; DIM = 140 ± 38) were selected from the high-producing pen (as described in von Keyserlingk et al., 2012) to be assessed for hock injuries. Hock (lateral surface of the tarsal joint) injuries were assessed during milking on a 3-point scale, where 1 = healthy hock and 3 = swollen hock, open wound, or both, according to the Hock Assessment Chart for Cattle developed by Cornell Cooperative Extension (http://www.ansci.cornell.edu/prodairy/pdf/hockscore.pdf). Only one hock per cow was considered for this assessment because of the difficulty in examining the opposite side in herringbone parlors. A total of 2,091 cows were scored. The percentage of cows with clinical hock injury (score ≥2) and with severe hock injury (score = 3) were calculated.

Knee (carpal joint) injuries were recorded as present (evidently swollen joint with or without skin damage) or absent on each knee (as described in von Keyserlingk et al., 2012). All cows in the high-producing group were examined in 27 of the herds and only the focal cows were examined in the other 26 herds. A total of 5,739 cows were scored. The percentage of cows with at least one knee injury was calculated.

A total of 3 trained observers performed the lameness and leg injury assessments, but within any one herd the same observer scored all cows for lameness and injuries. Prevalence-adjusted bias-adjusted kappa (Byrt et al., 1993; Thomsen and Baadsgaard, 2006) was calculated to assess inter-observer agreement for each lameness and leg injury score; this kappa estimate ranged from 0.83 to 0.93 ($P < 0.001$), indicating near-perfect agreement (Landis and Koch, 1977).

Reproductive outcomes were retrieved from Dairy Comp 305 (Valley Ag Software), considering the total number of multiparous cows (lactation ≥2) present in the herd at the time of the visit and the multiparous cows culled or sold in the 14 mo before the herd visit. On average (±SD), 1,045 ± 792 multiparous cows per herd were included in the analysis (n = 55,361 multiparous cows in total). The following cow-level reproductive outcomes were retrieved: calving to first AI interval (considering all multiparous cows except for fresh cows that had not yet been bred), CCI (considering multiparous cows with confirmed pregnancy), and CI between the last 2 calving events. The distribution of the calving to first AI intervals was used to estimate the voluntary waiting period (**VWP**), defined as the interval postpartum by which 10% of the multiparous cows with a first AI had received their first AI (Miller et al., 2007). Four herd-level reproductive