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# Herd-level risk factors for hock injuries in freestall-housed dairy cows in the northeastern United States and California

**A. K. Barrientos,* N. Chapinal,* D. M. Weary,* E. Galo,† and M. A. G. von Keyserlingk*[1]**
*Animal Welfare Program, Faculty of Land and Food Systems, University of British Columbia, 2357 Main Mall, Vancouver, V6T 1Z4, Canada
†Novus International Inc., 20 Research Park Drive, St. Charles, MO 63304

## ABSTRACT

The aim of this study was to investigate the associations between management and facility design factors and the prevalence of hock injuries in high-producing dairy cows in 76 freestall herds in the northeastern United States (NE-US; Vermont, New York, Pennsylvania) and California (CA). One group of high-production multiparous cows was monitored on each farm, and data on management, facility and stall design, and the conditions of the hocks were collected. Focal cows [n = 38 ± 3 (mean ± standard deviation)] were evaluated for hock injuries using a 3-point scale (where 1 = healthy and 3 = evidently swollen or severe injury). Measures associated with the proportion (logit-transformed) of cows having injuries (score ≥2) or severe injuries (score = 3) at the univariable level were submitted to multivariable general linear models. In NE-US, overall hock injuries increased with the percentage of stalls with fecal contamination [odds ratio (OR) = 1.26; 95% confidence interval (CI) = 1.02–1.54, for a 10% increase], and with the use of sawdust as bedding (OR = 3.47; CI = 1.14–10.62), and decreased with deep bedding (i.e., at least 10 cm depth of any type of bedding; OR = 0.05; CI = 0.02–0.14), use of sand as bedding (OR = 0.06; CI = 0.02–0.15), bedding dry matter (DM) ≥83.9% (OR = 0.08; CI = 0.03–0.20), and access to pasture during the dry period (OR = 0.17; CI = 0.05–0.53). When these variables were submitted to a multivariable model, the presence of deep bedding was the only factor that remained significant, explaining 54% of the variation in overall injuries. Severe hock injuries increased with the use of automatic scrapers (OR = 2.29; CI = 1.11–4.71) and the percentage of stalls with fecal contamination (OR = 1.14; CI = 1.00–1.31, for a 10% increase), and decreased with sand bedding (OR = 0.22; CI = 0.10–0.49), deep bedding (OR = 0.24; CI = 0.11–0.52), bedding DM ≥83.9% (OR = 0.28; CI = 0.14–0.58), and access to pasture during the dry period (OR = 0.42; CI = 0.18–0.97). The final multivariable model, which explained 36% of the variation in severe hock injuries, included the use of automatic scrapers and deep bedding. In CA, stall stocking density (OR = 1.41; CI = 1.00–2.01, for a 10% increase) and poor bedding maintenance (OR = 1.08; CI = 1.01–1.16, for a 2.5-cm decrease in depth of deep-bedded stalls) were associated with an increase of overall and severe hock injuries, respectively. Deep-bedded and well-maintained stalls reduce the risk of hock injuries. Regional variation in risk factors for these injuries should be considered when formulating on-farm recommendations.
**Key words:** skin lesion, bedding management, stall design, dairy cattle welfare

## INTRODUCTION

Despite over a decade of research (e.g., Weary and Taszkun, 2000; Cook et al., 2008; Lombard et al., 2010) showing the effects of facility design and management on skin lesions, these injuries are still common on dairy cows. Lesions on the legs of cattle are most often observed on anatomical protrusions, such as joints, with the most common lesions found on the tarsal joint (hock) (Rutherford et al., 2008; Kielland et al., 2009). These injuries can range from a small area of hair loss to open wounds, and can be accompanied by swelling of the entire joint (Weary and Taszkun, 2000). Assessments on European commercial dairy farms have shown that the prevalence of hock lesions is as high as 100% on some farms (Norway: Kielland et al., 2009; Germany: Brenninkmeyer et al., 2013) and that substantial variation in prevalence exists, averaging from 22 to 61%, depending on the characteristics of the housing system and season (United Kingdom; Rutherford et al., 2008). The lack of progress in reducing prevalence is surprising given that these injuries are relatively easy to recognize.

In North America, several studies (e.g., Weary and Taszkun, 2000; Fulwider et al., 2007; Lombard et al., 2010) have estimated the prevalence of hock injuries in dairy cattle and some have shown associations between housing and lesions. Hock injuries appear to be most

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[1]Corresponding author: nina@mail.ubc.ca

prevalent and severe in poorly bedded freestall barns (often using concrete, rubber mats or mattresses as a stall base) compared with deep-bedded freestalls or open bedded packs (Fulwider et al., 2007). However, major regional differences exist in housing and management practices (driven in part by local availability of different types of bedding). These regional differences may explain some of the apparent disagreements in previous work. For example, Weary and Taszkun's (2000) study in British Columbia found that the risk of lesions was lowest on farms using sand bedding, whereas Keil et al. (2006) found that straw bedding worked best on Swiss dairies. To our knowledge, no work has investigated how risk factors vary across regions.

The current study was part of a larger cross-sectional project that aimed to describe variation in the prevalence of lameness, leg injuries, lying behavior, facility design, and management practices for high-producing cows on freestall dairy farms in North America (von Keyserlingk et al., 2012). This study reports the risk factor analysis for 2 regions of the United States with different environmental conditions and different traditions of barn design and management: the northeastern United States (Vermont, New York, and Pennsylvania; **NE-US**) and California (CA). The aim was to investigate the association between management and facility design factors and the prevalence of hock injuries in high-producing dairy cows in freestall herds in these 2 regions.

## MATERIALS AND METHODS

### Farm Selection and Visits

This study was part of a benchmarking project intended as a service for producers. The C.O.W.S. program (a partnership between The University of British Columbia, Vancouver, BC, Canada, and Novus International Inc., St. Charles, MO; http://www.novusint.com/en/Market-Segments/Dairy/COWS) was designed to monitor the high-producing group on freestall farms (von Keyserlingk et al., 2012). Although all participating farms made use of freestall housing, farms varied in facility, management, and production characteristics with important geographical differences (full description of herd characteristics by region described in von Keyserlingk et al., 2012). 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).

To summarize, consulting nutritionists (n = 8 in CA; n = 24 in NE-US) were asked to randomly select farms from among their lists of clients, considering 3 inclusion criteria: Holstein herds, freestall housing, and provision of a TMR. In total, 38 farms in NE-US (New York n = 28, Pennsylvania n = 6, and Vermont n = 4) and 38 farms in CA were selected for this study. Farms were visited from March to May 2010 in CA, and from July to October 2010 in NE-US. Each farm was visited twice, with 4 to 7 d between visits. The same 2 trained observers performed all animal- and facility-based measures (Table 1) on all farms in each of the 2 regions. At the beginning of the first visit to each farm, the producer was asked to identify for assessment one group of high-producing, primarily multiparous, cows. On farms where producers identified more than one high-producing group, the pen that more closely met our inclusion criteria was chosen.

### Hock Assessment

Before data collection, a target sample per assessment group was estimated to be 21 cows, based on 90% confidence of detection of a 10% prevalence of severe hock injuries in a pen of 200 cows (Dohoo et al., 2009). However, because of the larger sample required for other animal-based measurements sampled in the same project (e.g., lying time; Ito et al., 2009), 40 focal cows from the assessment group were systematically selected while entering the milking parlor and were evaluated for hock injuries during the first visit to the farm. Selection of the cows was done based on the order they entered the milking parlor; for example, if the assessment group had 120 cows, every third cow that came into the parlor was chosen until 40 focal cows were selected. Only data from multiparous cows were used in this study; thus, 1 farm in CA and 2 in NE-US were excluded from the analysis because $\leq$20 multiparous cows were assessed for hock injuries in the assessment group. The number of multiparous focal cows sampled per assessment group in the remaining farms was [mean $\pm$ SD (range)] 38 $\pm$ 3 (27 to 40) individuals. A total of 1,450 and 1,423 cows were sampled in NE-US and CA, respectively.

Each selected animal was scored for hock condition (lateral surface of the tarsal joint) on a 3-point scoring system, where 1 = healthy hock without alopecia, 2 = bald area on the hock without evident swelling, and 3 = evidently swollen, severe injury, or both, according to the Hock Assessment Chart for Cattle developed by Cornell Cooperative Extension (http://www.ansci.cornell.edu/prodairy/pdf/hockscore.pdf). No other locations of the rear limb were evaluated for injuries. Only 1 limb per animal was considered for this assessment because of the difficulty in examining the opposite side in some type of parlors (i.e., herringbone parlor). Regardless of the type of parlor, we systematically scored the right hock of half of the animals and the left hock