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Herd-level risk factors for seven different foot lesions in Ontario Holstein cattle housed in tie stalls or free stalls

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ABSTRACT

Worldwide, there is considerable between-herd variation within individual foot lesion prevalence studies. This variation suggests that herd-level risk factors are important from a prevention perspective. The objective was to determine the effect of selected risk factors on the prevalence of 7 foot lesions in both tie-stall and free-stall housing systems. As part of a cross-sectional foot lesion study 5 hoof trimmers recorded lesions for all cows that were foot trimmed in a herd. In addition, they completed a risk factor questionnaire for each herd. The impact of specific risk factors was evaluated using separate multi-variable models for both free-stall and tie-stall herds. The lesions evaluated were digital dermatitis, sole ulcer, sole hemorrhage, heel horn erosion, white line separations, white line abscess, and interdigital fibroma. Model types were selected based on herd-level lesion distribution. Detrimental risk factors identified in free-stall housing included increased alley scraping frequency (2.2- to 2.4-fold for sole ulcers) and trimming in summer or fall (−0.2-fold vs. spring and winter for digital dermatitis). Protective risk factors in free stalls included intermediate bedding depth (0.4-fold for 2.5 to 7.5 cm vs. more or less bedding for interdigital fibroma) and trimming heifers before calving (0.1-fold for white line abscess). In tie-stall herds no protective risk factors were identified. Detrimental risk factors for lesions in tie stalls included year-round access to outside areas (2.1-fold increase in digital dermatitis, 3.5-fold for white line separation, and 7.0-fold for interdigital fibroma vs. no or only seasonal exercise access), routine spraying of feet (2.0-fold increase in digital dermatitis), larger herds (3.0-fold increase in interdigital fibroma vs. <41 cow herds), and the use of wood bedding material (6.5-fold vs. straw bedding for interdigital fibroma). The risk factors identified need further evaluation to determine the temporal relationships, as well as whether the relationships with foot lesions are causal.

Key words: foot lesion, risk factor, tie stall, free stall

INTRODUCTION

In the past 15 to 20 yr, very little progress has been made in reducing the prevalence of lameness in North America (Wells et al., 1993; Cook, 2003). The most recent estimates of lameness prevalence are 20 to 22% and 23 to 27% in North American tie-stall and free-stall barns, respectively (Cook, 2003; Zurbrigg et al., 2005). These prevalence estimates are based on locomotion scores and should be considered an indicator of clinical disease. The prevalence of subclinical disease such as foot lesions identified at routine hoof trimming is likely higher (Manske et al., 2002).

Currently, there is a paucity of North American foot lesion data collected from multiple tie-stall or free-stall herds. Estimates from Europe indicate that prevalence of foot lesions is approximately 50% in tie-stall housing systems (Sogstad et al., 2005) and 70 to 80% in free-stall housing (Somers et al., 2003; Sogstad et al., 2005). In these and other European studies, there is considerable between-herd variation in lesion prevalence. Furthermore, herd-level variance makes a large contribution to the total variance for most lesions (Manske et al., 2002; Sogstad et al., 2005; Holzhauer et al., 2006a). This large between-herd variation suggests that herd-level risk factors may be important determinants of lesions and lameness in dairy cattle.

The importance of herd-level risk factors in the control of lameness and foot lesions was reviewed by Bergsten (2001). Yet, at that time, there were very few multi-variable herd-level epidemiological techniques and studies on which to base management recommendations (Hirst et al., 2002). Historically, the majority of studies that identified potential risk factors for the control of lameness were based on producer-recorded lameness data (Rowlands et al., 1983; Faye and Lescourret, 1989). Still, recent studies have used either locomotion scoring (Amory et al., 2006) or foot lesions

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found at routine hoof trimmings (Sogstad et al., 2005; Somers et al., 2005a; Holzhauer et al., 2006b) to identify potential risk factors. The use of foot lesion or locomotion data decreased the underestimation problems that commonly occur with producer-recorded lameness data (Whay et al., 2002), but can still be affected by misclassification bias on the part of the hoof trimmer(s) (**HT**; Holzhauer et al., 2006a).

A variety of lameness risk factors have been identified. Unfortunately, there are considerable differences in breeds, housing, nutrition, and management between these predominantly European studies and typical dairy farms in Ontario and the rest of North America. One difference is that most of the European studies focused mainly on herds using free-stall housing systems. Because most farms in Ontario still use tie stalls for housing milking cows (Zurbrigg et al., 2005), there is a need to identify important risk factors in typical Ontario and other North American conditions. Knowledge of such factors could be used to design hoof health management programs to reduce the prevalence of lameness and foot lesions in both tie-stall and free-stall housing systems.

The objective was to evaluate relationships between selected herd-level risk factors and foot lesion prevalence in Ontario tie-stall and free-stall dairy herds.

MATERIALS AND METHODS

Five professional HT were recruited to enroll herds for participation. From March 2004 to May 2005, HT recorded the presence of foot lesions on all cows trimmed in participating herds. Details of lesion recording methods and HT recruitment and training are described elsewhere (Cramer et al., 2008). Briefly, participants were recruited via a mailing to HT that advertised in dairy industry magazines or were listed in a provincial database. Hoof trimmers that responded were trained in lesion identification at the onset of the project using digital images of common lesions. At the conclusion of the project, HT were evaluated to ensure lesion identification remained consistent. Recording forms were provided that contained lesion codes based on the recommendations of the American Association of Bovine Practitioner's lameness committee (Shearer et al., 2004).

As well as recording lesions, HT administered a 3-page questionnaire that captured descriptive herd management data from each of the participating farms. The questionnaire included items pertaining to farm characteristics (breed, herd size, milk production, housing, flooring, bedding management, and pasture access), hoof health management (trimming routine, foot disinfection), and nutrition (feeding management, additive use). Farms with missing or deficient data on the questionnaires were contacted in an attempt to fill out missing data. For herds using a DHI milk recording service, production and herd size data were taken from DHI records; otherwise, they were calculated from questionnaire data.

Data Management and Statistical Analysis

Both questionnaire and lesion data were entered into a database (MySQL 4.1, MySQL AB, Uppsala, Sweden) via the Internet. Data management and descriptive analyses were done using Microsoft Excel (Redmond, WA) and a commercially available statistical program (Stata 9.2, Stata Corp., College Station, TX). Individual cows with duplicate, unreadable, or missing cow identification were removed from the data set.

For each herd, lesion-specific prevalence was calculated in the following manner: the number of affected cows was divided by the number of cows examined during the particular hoof trimming visit. For each cow, foot lesion data were recorded on all 4 limbs and these data were collapsed into a single record for each cow. A cow was considered affected with a particular lesion if at least 1 foot had the lesion present. Cows with multiple lesions were considered affected for all lesions present on the feet. Several herds had multiple hoof-trimming dates, but only the data from the visit at which the questionnaire was administered were included in the analysis.

Because of differences in risk factors between free stall and tie stalls, all analyses were performed separately for tie-stall and free-stall herds. Multivariable models were created for each specific lesion, including digital dermatitis (**DD**), heel horn erosion (**HHE**), sole ulcer, white line disease abscess (**WLA**), white line disease separation (**WLS**), hemorrhage (**HEM**), and interdigital fibroma.

Multivariable models were built in multiple stages, the first of which was to determine the type of model to be used. This determination was made by graphically assessing the distribution of herd prevalence for each lesion. If the distribution appeared close to a normal distribution, linear regression was used. When the distribution was not close to a normal distribution and less than 40% of the herds had a prevalence of zero, a negative binomial regression model was selected. If more than 40% of the herds had zero prevalence, herds were classified as affected or unaffected with each specific lesion and logistic regression was used. Logistic regression was used instead of zero-inflated negative binomial regression because of a large number of herds with zero counts and the lack of variability between affected herds.