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Validation of the M-stage scoring system for digital dermatitis on dairy cows in the milking parlor

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ABSTRACT

A high prevalence of digital dermatitis (DD) and the benefits of early topical treatment highlight the need for simple tools for routine DD detection. The objective of this study was to determine the accuracy of scoring DD lesions using the 5 M-stage scoring system in the milking parlor compared with the trimming chute as the gold standard. Three observers inspected 3,585 cows and 6,991 hind feet from 9 farms in the milking parlor using a mirror (glued to a plastic kitchen spatula) and a headlamp, followed by inspection in a trimming chute within 5 d. Interobserver agreement for scoring DD in various settings was ≥82% (kappa >0.74; weighted kappa >0.76). At trimming chute inspections, 68% of cows had at least 1 DD lesion, 19% had 1 hind leg affected, and 49% had both hind legs affected. Within-herd DD prevalence ranged from 16 to 81% of cows affected. True within-herd prevalence was 2, 6, 0, 36, and 14% for M1, M2, M3, M4, and M4.1 lesions, respectively. At the foot level, DD prevalence was the same (58%) in the milking parlor and trimming chute inspection, but distribution of M-stages differed. Milking parlor inspection as a means of identifying the presence of DD lesions had a sensitivity of 92% and specificity of 88%, with positive and negative predictive values of 91 and 89%, respectively. Agreement between milking parlor and trimming chute inspections was 73% (kappa = 0.59, weighted kappa = 0.65) for the 5 M-stage scoring system and 90% (kappa = 0.80) if only the presence of a lesion was noted. Test characteristics varied greatly among M-stages, with the highest sensitivity for detecting M4 (82%) and M2 (62%) lesions, and the lowest for detecting M4.1 (20%), M1 (7%), and M3 (0%) lesions. In the milking parlor, 20% of M2 lesions were misclassified as M4.1, 8% of M4 lesions were misclassified as M0, and 68% of M4.1 lesions were misclassified as M4. The majority (87%) of DD lesions were located between the heel bulbs; 10 and 2% of DD lesions affected the interdigital space and the front of the foot, respectively. The sensitivity to detect the presence of a lesion when it occurred between the heel bulbs was 93%, but <67% if it occurred elsewhere on the foot. We concluded that inspection of the rear feet in the milking parlor was an inexpensive and simple method of detecting and scoring DD lesions. If the objective is to determine herd-level DD prevalence and routine monitoring, this method was adequately reliable. However, if the objective is to follow up DD in cows with history of interdigital hyperplasia or to detect M1 or M4.1 lesions, this method was not sufficiently reliable. Although DD scoring in the milking parlor as a routine practice should facilitate early detection, prompt treatment interventions, and herd monitoring, it was not sufficiently reliable to replace definitive identification of M-stages in the trimming chute.

Key words: dairy cattle, diagnostic test, lesion scoring, hoof trimming, digital dermatitis

INTRODUCTION

Digital dermatitis (**DD**) is a widespread bacterial foot lesion in cattle that typically develops on the bulb of the heel, causing ulcerative lesions that may be uncomfortable or very painful (Cheli and Mortellaro, 1974; Döpfer et al., 1997). It is the most common foot lesion in confined dairy systems, with a prevalence ranging from 15 to 49% (Holzhauer et al., 2006; USDA, 2009; Solano et al., 2016) and causing substantial economic losses due to high incidence and prevalence and the related costs of decreased reproductive performance, increased risk of culling, treatment and labor (Bruijnis et al., 2010; Cha et al., 2010; Gomez et al., 2015b).

As a consequence of pain, cows affected with DD often change their gait or posture to avoid contact with the floor, exhibiting decreased mobility, lifting or shaking the affected leg, or walking with a toe-down posture (Rodriguez-Lainz et al., 1998; Shearer and Van Amstel, 2013). Digital dermatitis is considered a multifactorial and polybacterial disease, with treponemes consistently isolated from DD lesions (Döpfer et al., 2012b; Gomez et al., 2012; Krull et al., 2016). The pathogen can remain

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endemically present in a herd, and infected cattle can develop active and chronic stages of infection. Chronically infected cattle are a reservoir of infection and a potential source of outbreaks (Döpfer, 2009; Döpfer et al., 2012a). Additionally, affected cows can experience changes in the heel area, favoring persistence and occurrence of heel horn erosion, an infectious lesion (Gomez et al., 2015a). Thus, DD is a serious animal welfare concern due to painful episodes that can be long lasting, with recurrent outbreaks (Bruijnis et al., 2012; Döpfer et al., 2012a; Gomez et al., 2015b).

Routine monitoring of DD enables early detection and treatment, key factors for the effective management of the disease (Döpfer et al., 2012a). Numerous classification systems for DD have been developed (Laven, 1999; Manske et al., 2002; Vink, 2006; Krull et al., 2014), but over the last 15 years, the scientific community has widely used the M-stage scoring system developed by Döpfer et al. (1997) and amended by Berry et al. (2012). Based on visual observation, this scoring system characterizes various clinical stages of DD over the course of the disease, allowing for observation of transitions between active, chronic, and healed stages. This information provides researchers, farmers and hoof trimmers a tool for monitoring the effectiveness of DD control programs at both individual-animal and herd levels (Döpfer et al., 2012a).

The M-stage scoring system enables macroscopic scoring of DD lesions and is internationally recognized as the most accurate and detailed DD identification system (Greenough et al., 2008), although misclassification bias is expected as diagnosis is based on visual inspection (Relun et al., 2011). Lifting the cow's foot for inspection in the trimming chute continues to be the gold standard for DD detection, although it is expensive, labor-intensive, and stressful for cattle (Thomsen et al., 2008; Relun et al., 2011; Stokes et al., 2012). Furthermore, trimming chute inspections are not practical for assessing disease prevalence, either on a regular basis, or for early DD detection and treatment.

Consequently, alternative diagnostic tools for DD detection have been developed; for example, inspection of hind feet during milking in the parlor with the assistance of a swiveling mirror (Relun et al., 2011) or borescope (Laven, 1999; Vink, 2006; Stokes et al., 2012), or with no specialized tools (Rodriguez-Lainz et al., 1998; Thomsen et al., 2008). In addition, DD has been diagnosed during pen walks while cows were restrained in headlocks (University of Wisconsin, 2013) or by using blood tests to detect active DD cases (Gomez et al., 2014). The 6 studies that evaluated the accuracy of DD detection in the milking parlor used various classification systems for DD, and the majority did not distinguish among DD M-stages. It is noteworthy that the 1 study that used the M-stage scoring system (Relun et al., 2011) was conducted before the release of the updated scoring system (Berry et al., 2012). In addition, the other 5 studies used a tool that was either expensive or impractical for field conditions (Laven, 1999; Vink, 2006; Stokes et al., 2012) or insufficiently accurate (Rodriguez-Lainz et al., 1998; Thomsen et al., 2008). Simple, inexpensive, and effective tools are needed for routine DD inspection. The objective of this study was to determine the accuracy of detection and scoring DD lesions using the updated M-stage scoring system in the milking parlor, as compared with the trimming chute.

MATERIALS AND METHODS

Farm and Cow Selection

A total of 17 freestall dairy farms in Alberta, Canada, clients of 2 hoof trimmers, were contacted by telephone to be enrolled as part of a longitudinal study examining the effectiveness of a standardized footbath protocol for prevention of DD (Solano et al., 2017). To ensure that participating farms were representative of the majority of farms in Alberta, farms were selected that had free stall housing systems with no access to pasture, and a herd size of ≥90 Holstein-Friesian lactating cows. Farms were also selected based on convenience criteria: cows had to be milked in a milking parlor, and farms had to have ≥10% DD prevalence, based on hoof trimming records from the past year. Ten farms met all criteria and agreed to participate in the study. One farm withdrew 1 mo after field data collection had started, because of a change in farm ownership. Data were collected between November 2013 and June 2014 by the corresponding author and 2 trained observers from the University of Calgary (Calgary, AB, Canada). All methods were approved by the Animal Care Committee and Research Ethics Board of the University of Calgary (AC13–0082).

DD Lesion Assessment

The DD lesions were scored using the 5-point scale according to Döpfer et al. (1997) and Berry et al. (2012). Briefly, lesions were classified as M0 if skin was normal with no lesions compatible with DD; M1 if a small (<2 cm in diameter) focal active lesion was observed, with a red-gray surface and scattered small (~1 mm in diameter) red foci; M2 if an ulcerative active lesion ≥2 cm in diameter was observed, with a red-gray surface; M3 (healing stage) if lesion presented