



J. Dairy Sci. 101:1–9
<https://doi.org/10.3168/jds.2017-13755>

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Evaluation of agreement among digital dermatitis scoring methods in the milking parlor, pen, and hoof trimming chute

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ABSTRACT

Digital dermatitis (DD) is the most common infectious foot lesion affecting welfare and productivity of dairy cattle. The key to DD control programs is routine and frequent identification of DD lesions. The objective was to evaluate accuracy of detecting and scoring DD lesions in 3 milking parlor designs and in 3 alternative settings compared with scoring in the hoof trimming chute as reference. A total of 552 cows and 1,104 hind feet from 17 freestall farms were scored by 1 observer in the milking parlor and in 1 other setting: pen, headlocks, or management rail. After being scored in the milking parlor and at least 1 other setting, cows were examined in the hoof trimming chute, considered the gold standard. In every setting, all hind feet were inspected visually using a flashlight and without prior washing of feet. Agreement of the scoring settings was assessed using the 5 M-stage scoring system and a dichotomous absence (M0 or M0/M1) or presence (M1 to M4.1 or M2 to M4.1) system. At trimming chute inspection, 44% of feet had a DD lesion, with estimates of 11, 5, 2, 10, and 16% for M1, M2, M3, M4, and M4.1 lesions, respectively. Apparent DD foot-level prevalence at the milking parlor, pen, management rail, and headlocks was 28, 22, 16, and 22%, respectively. M-stages were less discernible in the pen, management rail, and headlocks (apparent prevalence of M1, M2, M3, and M4.1 was $\leq 1\%$) compared with the trimming chute and milking parlor. Agreement beyond chance between any scoring setting and trimming chute scoring ranged from 0.48 to 0.70 for the dichotomous scoring system (absence = M0/M1 vs. presence = M2 to M4.1). Diagnostic test performance varied greatly among DD scoring settings but, in general, it had low sensitivity (<70%) and high specificity (>93%) for detecting any DD lesion. Agreement and test characteristics were not

affected by the type of milking parlor. Although the milking parlor and headlocks were the most reliable settings in which to detect DD, none of the settings were reliable enough to replace inspection of feet in the trimming chute. However, scoring the presence or absence of DD in the milking parlor, pen, management rail, and headlocks could be used to estimate within-herd DD prevalence, to improve DD surveillance through routine monitoring, and to evaluate effects of interventions at the farm level.

Key words: digital dermatitis, pen walk, diagnostic test, dairy cattle, hoof trimming

INTRODUCTION

Digital dermatitis (DD) is one of the most common foot lesions in confined dairy cattle, affecting 70 to 94% of herds (Cramer et al., 2008; USDA, 2009; Solano et al., 2016) and approximately 20% of cows at the time of hoof trimming (Holzhauer et al., 2006; Cramer et al., 2008; Solano et al., 2016). The disease has considerable negative economic impact on milk production and reproductive performance (Relun et al., 2013; Gomez et al., 2015), causes increased treatment and labor costs (Bruijnis et al., 2010; Cha et al., 2010), and poses a serious welfare concern due to pain and discomfort (Bruijnis et al., 2012).

Digital dermatitis is polybacterial, with *Treponema* spp. consistently present in lesions and considered to have an important causative role (Evans et al., 2008; Gomez et al., 2012; Krull et al., 2014). Clinically, the disease is characterized by circumscribed ulcerative or hyperkeratotic lesions predominantly affecting the plantar aspect of the interdigital cleft or the interdigital space of the foot (Read and Walker, 1998; Berry, 2001). The course of DD infection progresses through distinct morphological stages. Several classification systems for DD have been developed based on clinical (Laven, 1999; Manske et al., 2002; Vink, 2006) and combined clinical and microbiological findings (Döpfer et al., 1997; Krull et al., 2014). Nevertheless, the M-stage scoring sys-

Received August 28, 2017.

Accepted November 5, 2017.

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tem, developed by Döpfer et al. (1997) and amended by Berry et al. (2012), is currently the most widely adopted scoring system (Greenough et al., 2008; Zinpro International Bovine Lameness Committee, 2014) and characterizes 5 clinical stages of DD based on clinical appearance.

To minimize the detrimental effects of DD on the animal and the farm, rapid detection methods are needed. In addition, an accurate rapid scoring method would facilitate evaluation of the effect of changes to management practices at the herd level; for example, monitoring DD before and after changing footbathing practices (Solano et al., 2017b). Locomotion scoring is commonly used to identify lame cows (Sprecher et al., 1997; Flower and Weary, 2006); however, it is not a sensitive diagnostic test for DD because a large proportion of cows with DD are not lame (Cramer, 2007).

The gold standard for diagnosing DD is visual inspection of the foot in a hoof trimming chute; however, this is not an efficient method of detection due to the labor, time, cost, and disruption in a cow's time budget. Consequently, alternative scoring areas and methods have been developed to identify cows with DD in the milking parlor (Thomsen et al., 2008; Relun et al., 2011; Stokes et al., 2012; Solano et al., 2017a), in headlocks, or during pen walks (Jacobs et al., 2017). Various methods have been used to score cows in the milking parlor, including with a mirror (Relun et al., 2011; Solano et al., 2017a) or borescope (Laven, 1999; Stokes et al., 2012), without any tool (Rodriguez-Lainz et al., 1998; Thomsen et al., 2008; Oliveira et al., 2017), or without prior washing of cows' feet (Oliveira et al., 2017). Both the milking parlor and pen walk studies compared DD scores to the gold standard of hoof trimming chute inspection. Methods used by Laven (1999) and Stokes et al. (2012) were considered impractical due to the cost of the tool used and the effect on milking duration. Most of these studies evaluated only a few farms and the accuracy of the detection method was affected by the difficulty in accessing hind feet in certain parlor configurations (Thomsen et al., 2008; Stokes et al., 2012). In addition to the effect of milking parlor design and tool used, the various DD scoring systems used among studies make it difficult to compare detection methods. In most studies, the more detailed the description of lesions attempted (e.g., by color, depth, or stage), the lower the agreement and test characteristics compared with the gold standard. Conversely, the highest agreement generally results from simplifying DD into "present" and "absent" (Relun et al., 2011; Stokes et al., 2012; Solano et al., 2017a). Currently, most alternative scoring method studies have attempted to score DD in the milking parlor. However, scoring DD in areas other than the

milking parlor could be useful because different parlor designs likely affect accuracy of DD detection (Thomsen et al., 2008), and scoring in the milking parlor can be disruptive to the milking process. Furthermore, with the increasing presence of automatic milking systems worldwide, there is a need for alternative scoring areas.

The objective was to evaluate the accuracy of detecting and scoring DD lesions in 3 parlor designs and in 3 alternative settings compared with scoring in the hoof trimming chute as reference. Our hypothesis was that there is a difference in test characteristics among the 3 parlor types and alternative settings.

MATERIALS AND METHODS

Farm and Cow Selection

A total of 17 farms in Wisconsin ($n = 5$) and Minnesota ($n = 12$), clients of hoof trimmers, veterinarians, nutritionists, and Zinpro Corporation's field staff, were recruited by e-mail and telephone to be enrolled in this convenience sample study. Eligible farms met the following criteria: freestall housing; a herringbone, parallel, or rotary milking parlor; a professional hoof trimmer employed regularly; and endemic DD. Farms were selected mainly on parlor type, with a goal of including 10, 5, and 5 herringbone, parallel, and rotary parlors, respectively. Data were collected between May and August 2014. All procedures were approved by the University of Minnesota Institutional Animal Care and Use Committee (1312-31180A).

Selected farms were visited before or on the day of hoof trimming. Sampling of study cows was a purposive selection of cows for trimming determined by farm personnel as part of the farm's regular hoof trimming schedule.

Feet Assessment

On 16 of the farms, cows' hind feet were scored for DD in the milking parlor and in 1 additional setting: pen, headlocks, or management rail. On 1 farm, feet were scored in the milking parlor and in 2 additional settings. A single observer (second author) scored all cows in all settings, by approaching cows from behind and observing the hind feet while cattle were restrained (in headlocks, milking parlor, or management rail) or free roaming (in pen). While scoring cows at the headlocks, management rail, and pen, the observer tried to get as close as possible to the cows' hind feet by slightly bending or squatting. In all settings, hind feet were scored without prior cleaning or washing. Illumination levels and type (natural light, artificial light, or both)

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