J. Dairy Sci. 100:1–11
https://doi.org/10.3168/jds.2017-12815

Associations between biosecurity practices and bovine digital dermatitis in Danish dairy herds

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ABSTRACT

The relationship between biosecurity and digital dermatitis (DD) was evaluated in 8,269 cows from a convenience sample of 39 freestall dairy herds. The hypothesis was that poor implementation of biosecurity was associated with higher within-herd prevalence of DD. All lactating cows were scored as negative or positive for DD at the hind legs during milking in the milking parlor. Information about biosecurity was obtained through questionnaires addressed to farmers, on-farm observations, and information from the Danish Cattle Database (www.seges.dk). These assessment tools covered potential infection sources of DD pathogens to susceptible cows (e.g., via animals, humans, manure, vehicles, equipment, and facilities). External and internal biosecurity measures were explanatory variables in 2 separate logistic regression models, whereas within-herd DD prevalence was the outcome. Overall DD prevalence among cows and herds were 24 and 97%, respectively; the within-herd DD prevalence ranged from 0 to 56%. Poor external biosecurity measures associated with higher prevalence of DD were recent animal purchase, access to pasture, lack of boots available for visitors, farm staff working at other dairy farms as well, hoof trimming without a professional attending, and animal transporters having access to cattle area. For internal biosecurity, higher DD prevalence were associated with infrequent hoof bathing, manure scraping less than 8 times a day, manure removal direction from cows to heifers, animal pens' exit without water hoses, manure-handling vehicle used in other activities, and water troughs contaminated with manure. These findings showed that improvements on biosecurity may be beneficial for controlling DD in dairy herds. The study is relevant for farmers facing problems with DD, as well as hoof trimmers, advisors, and veterinarians, who can use the results for optimized recommendations regarding biosecurity in relation to DD. Furthermore, our results might be considered by future studies investigating DD pathogen reservoirs and transmission routes.
Key words: hoof disorder, dairy cow, biosecurity, digital dermatitis

INTRODUCTION

Digital dermatitis (**DD**) is a major infectious hoof disease occurring worldwide in cattle herds (Laven and Logue, 2006). In Denmark, DD prevalence among dairy cows exceeded 20% (Thomsen et al., 2012b), and DD was present in 85% of dairy herds (Capion et al., 2008). *Spirochetes* of the genus *Treponema* are most commonly associated with DD lesions (Evans et al., 2012; Zinicola et al., 2015); these painful lesions can cause lameness, reduced milk yield, reproductive problems, and early culling (Bruijnis et al., 2012). Costs associated with DD were approximately $133 per case (Cha et al., 2010); moreover, annual losses attributed to DD in a dairy herd may be the greatest among hoof disorders, as the incidence of clinical cases is high (Bruijnis et al., 2010).

Preventive and curative measures against DD involve antibiotics and other chemicals applied in hoof baths or topically that are not entirely successful (Laven and Logue, 2006; Thomsen et al., 2008b; Berry et al., 2012; Döpfer et al., 2012; Thomsen, 2015). These strategies may cause environmental contamination and expenses associated with treatments and extra labor (Laven and Logue, 2006; Relun et al., 2013a). Furthermore, excessive use of antibiotics may have major negative effects on human and animal health due to the possible association with the development of antimicrobial resistance (Prescott, 2014). The focus on biosecurity to control infections in dairy production has increased including recommendations in general (Villarroel et al., 2007; Brennan and Christley, 2012; Sarrazin et al., 2014), and for specific diseases (Lindberg and Houe, 2005; Ellis-Iversen et al., 2008). The biosecurity concept comprises (1) external biosecurity to avoid introduction and minimize reintroductions of pathogens into a herd, and (2) internal biosecurity to reduce dissemination of pathogens between animals within a herd. Improved biosecurity implementation seems to improve animal

Received March 1, 2017.
Accepted July 1, 2017.
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health, welfare, and productivity, and reduce antibiotic use (Brennan and Christley, 2012; Laanen et al., 2013).

The influences that biosecurity, per se, may have for controlling DD is unclear; however, some conclusions can be drawn from studies of risk factors and potential infection reservoirs to susceptible cows. Regarding external biosecurity, cows in herds that purchased heifers had nearly 3 times higher odds of DD compared with cows in closed herds (Rodriguez-Lainz et al., 1999). Quarantine and hoof examinations before introducing new animals into herds are recommended, as DD was observed in 12.1% of cows presenting at auctions (Hulek et al., 2010). Herds visited by hoof trimmers who also attended other farms had 2.8 times higher odds of increased DD incidence (Wells et al., 1999). The contribution of these visitors' equipment is probably relevant, as DD *Treponema* were detected in 100% of trimming equipment used on cattle affected by DD (Sullivan et al., 2014). Because hoof lesions in other animal species (i.e., sheep, goats, and elk) have etiological, clinical, and pathological similarities to DD (Knappe-Poindecker et al., 2014; Clegg et al., 2015; Knappe-Poindecker, 2015; Sullivan et al., 2015a,b); the participation of these animals in DD circulation has become a concern.

With respect to internal biosecurity, farm hygiene and hoof health management improvements were previously highlighted to mitigate DD risks. They included adequate floor scraping (Somers et al., 2005), access of cows to pasture (Rodriguez-Lainz et al., 1999; Wells et al., 1999; Somers et al., 2005), prophylactic hoof washing and bathing (Rodriguez-Lainz et al., 1999; Thomsen et al., 2012a), and routine trimming with disinfection procedure (Wells et al., 1999; Somers et al., 2005; Relun et al., 2013b). However, many of these measures were not always effective (Holzhauer et al., 2006; Cramer et al., 2009). Given a hypothesis that poor biosecurity implementation in dairy herds is associated with higher prevalence of DD, our objective was to evaluate the relationship between external as well as internal biosecurity measures and within-herd DD prevalence in dairy cattle herds.

MATERIALS AND METHODS

Study Design and Population

This cross-sectional study involved Danish commercial dairy herds visited from January 2015 until July 2016. Selection of herds for recruitment was performed using a list of herds being members of the milk control association (RYK Registrering og YdelsesKontrol, 2015), which comprises over 90% of Danish dairy herds. For practical reasons, only herds located less than a 3-h drive from the Foulum campus of Aarhus University were considered; the majority of Danish dairy herds are located within this area. In addition to having more than 80 lactating cows per year, other inclusion criteria were a freestall housing system with a conventional or carousel milking parlor due to practicalities regarding the method for diagnosing DD (see next section). Our final list for recruitment comprised 310 herds that met the aforementioned inclusion criteria. Farmers were approached in a random order through a letter containing explanations about the study followed by a phone call approximately 1 wk later. We contacted farmers until 50 herd visits were scheduled to achieve the minimum estimated sample size. Written approvals granting access to herd data were acquired from farmers before data collection.

A sample size calculation used the 5% significance level and power of 80% in a 1-sided test. It was based on the comparison of the relative risk between farms with low and high level of biosecurity (i.e., exposed to a different range of biosecurity practices). The prevalence of DD in the reference group was assumed to be 0.25 considering findings from previous reports (Capion et al., 2008; Thomsen et al., 2012b), and the relative risk to be detected was set at 2.5. We referred to Houe et al. (2004) for the formula and assumptions used in calculations. A necessary sample size of approximately 40 herds was estimated.

DD Recordings

Clinical evaluations of hind feet were conducted on all lactating cows during milking in the milking parlor (Thomsen et al., 2008a) using a flashlight and a manual counter as supporting tools. Prior to the herd visits, a single observer (first author) was trained to score DD by an experienced researcher (last author) in 2 dairy herds that were not included in the study.

Washing procedures were performed before evaluating the feet. The observer washed the hind legs of cows after the milking equipment had been attached to the udder to avoid splashing of water contaminated with manure onto the teats during the procedure. Approximately 90% of DD lesions in dairy cows are found in the hind feet (Murray et al., 2002; Relun et al., 2011; Solano et al., 2016), so only the hind feet skin were evaluated. We used the M-stages classification to define DD cases (Döpfer et al., 1997; Berry et al., 2012). Cows were recorded as DD-positive depending on the presence of DD manifestations (M1–M4.1) in at least 1 of their hind feet or DD-negative if cows had normal skin of the hind feet (M0). Cows with unsuitable conditions for examination of hind feet were excluded from the study; that is, inappropriate hoof angles with low