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Short communication

Estimation of the relative impact of treatment and herd management practices on prevention of digital dermatitis in French dairy herds

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ABSTRACT

The purpose of this study was to concurrently estimate the effect of different digital dermatitis (DD) treatment regimens and herd management practices on the occurrence of a new DD lesion. A controlled clinical trial was conducted and involved 4678 dairy cows from 52 French dairy farms where DD was endemic. Farms were allocated by minimisation to one of 4 treatment regimens, varying through the mode (footbath or collective spraying) and the frequency of application (2 days every 4 weeks or fortnightly). They were visited 7 times every 4 weeks by 14 trained investigators. Frailty Cox proportional hazards models were used to estimate the relative effect of potential risk factors and treatment practices on the time until the first occurrence of a DD lesion. At herd level, high initial DD prevalence strongly increased the risk for DD occurrence (HR = 1.93, CI 1.23–3.04), as well as absence of hoof-trimming (HR = 1.75, CI 1.36–2.27) and poor leg cleanliness (HR = 2.44, CI 1.80–3.31). At animal level, Holstein breed (HR = 1.92, CI 1.35–3.57) and high-productive cows (HR = 1.26, CI 1.01–1.56) were identified to be at higher risk for DD compared to Normande breed and low-productive cows, respectively. Compared to individual topical antibiotic treatments alone, collective treatments tended to decrease the risk of DD occurrence only when applied over 2 days at least every fortnight (HR range = 0.64–0.73).

1. Introduction

Digital dermatitis (DD) is currently a major cause of lameness in dairy cows, reported worldwide, with particularly high prevalence in Western Europe and North-America (Holzhauer et al., 2006; Cramer et al., 2008). The disease causes serious economic losses, due to treatment cost and production losses, increases the use of antibiotics, and compromises animal welfare (Cha et al., 2010).

DD is considered a contagious and multifactorial disease, requiring exposure to a combination of pathogenic factors, mostly *Treponema* spp. (Klitgaard et al., 2008), and environmental factors, such as poor foot hygiene and wet conditions (Rodriguez-Lainz et al., 1996; Somers et al., 2005a). As a consequence, control measures should be focussed on limiting the exposure to risk factors and curing existing DD lesions.

Yet, two important obstacles are hindering efforts to improve DD control. First, there is a lack of knowledge regarding the effectiveness of farm control strategies derived from risk factor studies, with a need to test whether exposure to some management practices that can vary over time, such as access to pasture, is causally associated with DD. Second, there is a lack of knowledge on effective treatment strategies, particularly on the preventive

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effectiveness of collective treatment protocols based on feet disinfection (Laven and Logue, 2006). Recent studies often found no effect of alternative solutions to formalin and copper sulfate, to limit the occurrence of DD lesions (Manske et al., 2002; Thomsen et al., 2008; Speijers et al., 2010).

Additionally, the huge variety of treatment practices in the field may influence the spread of DD, and thus confound estimates of risk factors measured through observational field studies (Laven and Logue, 2006; Relun, 2011). In parallel, the effectiveness of treatment might depend on the farm situation, in terms of DD prevalence and severity (Laven and Logue, 2006), and leg cleanliness (Cook, 2006), but trials are often conducted in a limited number of farms (usually one to three), thus limiting the extrapolation of the results to farms with different characteristics.

The objective of this study was to estimate the relative influence of cow characteristics, farm facilities, herd management practices and several collective treatment practices on the occurrence of DD in endemically affected dairy herds. A similar approach has recently been used to identify the influence of the same factors on the healing of DD lesions (Relun et al., 2012).

2. Materials and methods

The data used for this study have been described in detail previously (Relun et al., 2012), and a brief outline is provided. All procedures were carried out under the agreement of the Ethics Committee for Animal Experimentation of Pays de la Loire (CEEA, France).

2.1. Study population

Fifty-two dairy farms located in western France were included in the study. These farms were selected as they were known to have experienced DD for over two years, and cows were milked in a milking-parlour (location for DD scoring and DD treatments). Farmers milked on average 70 cows (range: 29–129), twice a day. The median 305-day cow milk production was 8937 kg (range: 5357–12,636 kg) for Holstein cows, which represents more than 80% of the cows, and 6457 kg for Normande cows (range: 3369–9513 kg). Three farms had only Normande and 2 farms had half Holstein and half Normande breeds. In most farms, cows were housed in cubicles ($n = 45$), and had access to pasture in the spring and summer seasons ($n = 46$).

2.2. Treatment regimens and solutions

For ethical and welfare reasons, farmers were expected to individually treat all active DD lesions that they detected during the study period, with a specific protocol, *i.e.* 2 applications of oxytetracyclin (OTC, oxytetracycline chlorhydrate, 30 mg/ml, Oxytetrin P®, MSD Animal Health, Beaucouzé, France) 2 days apart, regardless of the treatment regimens to which they had been assigned. After one month applying only individual treatment, the farmers implemented one of four collective treatment regimens over a 6-month period: no collective topical treatment ("Control", 17 farms); footbath, after 4 consecutive milkings every 4 weeks (FB/4W, 11 farms) or every fortnight (FB/2W, 11 farms); collective spraying of the hind feet after 2 milkings 4 days apart on a fortnightly basis (CS/2W, 13 farms). The product used for collective topical treatments was a disinfectant solution whose active ingredients are copper and zinc chelates (5% Hoof-Fit Bath® and 50% Hoof-Fit Liquid®, Intracare, Veghel, The Netherlands). For all treatments, farmers had to wash the hind feet with a medium-pressure tap water before treating them.

Farms were assigned by minimisation to treatment regimens as they were recruited, in order to force treatment regimens to be balanced on initial DD prevalence.

2.3. Follow-up and data collection

The farms were visited from November 2009 to October 2010 by 14 trained investigators. After a pre-study visit, each farm was visited 7 times, approximately 4 weeks apart, with one visit just before the implementation of collective treatments and 6 follow-up visits. Each visit followed three steps: (1) scoring of the hind feet of all lactating cows for DD lesions and leg hygiene during milking, (2) checking any changes in management practices, and (3) checking compliance with the protocol.

DD status was assessed using a telescopic mirror and a powerful headlamp (Relun et al., 2011) and a 4-point nominal scale based on that first developed by Döpfer et al. (1997). M0 refers to normal skin, when no DD lesion is observed, M1 and M2 are the active stages with erosive to ulcerative circumscribed lesions smaller (M1) or larger (M2) than 2 cm in diameter, and M4 is the chronic stage characterized by dyskeratosic or hyperkeratosic epithelium. In cases with more than 1 lesion on a hind foot, the most active prominent DD lesion stage was recorded. Leg cleanliness was assessed using a 4-point nominal scale, varying from clean (score 1) to very dirty (score 4), as described by Cook (2006).

Detailed information about housing characteristics and management practices were obtained using a questionnaire filled in by the investigator and farmer together, as previously described (Relun et al., 2012). Data on breed, 305 days milk production, parity and lactation stage were obtained from the milk recording scheme.

2.4. Data analysis

The data were analyzed using a Cox proportional hazard model, in Survival kit® v6.0 (Ducrocq et al., 2010), using time to first DD occurrence in days from the date of entry of the study to estimate the hazard ratio for an exposure. Feet included in the analysis were those considered to have no active DD lesion (M0 or M4) when they entered the study. Feet observed with consecutive visits spaced more than 45 days were removed from analysis.The model included a farm and investigator nested frailty effects to adjust for the hierarchical clustering of feet within farms and investigators. Twelve factors were included as time-independent covariates (treatment regimen, herd size, purchase of cows, grazing system, housing system, initial farm DD prevalence, percentage of calving heifers, breed, milk yield level,