The association between footbath management and digital dermatitis in dairy cattle

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Contents

Abstract

The objective of this study was to identify whether the use and management of a footbath is a risk factor for digital dermatitis in 51 dairy farms located in the province of Alberta, Canada. Digital dermatitis lesion were recorded by trained hoof trimmers using the Hoof Supervisor® system. Information about the footbath management was collected through a questionnaire with the farmer. Odds ratios were calculated for the factors frequency of use, frequency of changing contents, sizes of the footbath and using products other than formaldehyde and/or copper sulfate. None of these factor could be determined as risk factors for digital dermatitis, due to small sample sizes and too much variation in footbath sizes and management. Since there was no consistency in the management of footbaths, this should be the focus of further research. Clear and understandable baselines for footbath management should be established and producers should be made aware of proper use of footbaths.

Introduction

Lameness is a major health and welfare problem in dairy cows. It considerably reduces the welfare of cattle, because it causes pain (23). This pain can be detected through a change in gait of lame cows (5). Providing analgesics to lame cows was shown to improve gait, indicating that the pain associated with lameness was mitigated (9). Besides the welfare issues, lameness causes significant economic losses. Main economic losses are due to a decrease in milk production (21), reduced fertility (10), treatment costs (4) and costs due to culling (3). The drop in milk production caused by lameness appeared to be greater for multiparous cows and for cows with more severe lameness, due to abscesses or sole ulcers (21). Furthermore, lame cows are at a greater or equal risk of being culled than non lame cows, but the decision to cull lame cows also seems to depend on the time the lameness is diagnosed (3). Infectious claw diseases are the most important causes of lameness in dairy cattle. Of the infectious claw diseases, digital dermatitis (DD) is most frequently diagnosed (6). Digital dermatitis will therefore be the main focus of this research. Cha et al. calculated the average cost per case of lameness due to DD at approximately 132.96 (US$) for DD. Milk losses contributed most to the total cost per case, followed by the effect of decreased fertility and treatment costs (4).

Digital dermatitis was first described in Italy, 1984, by Cheli and Mortellaro. It is also called hairy foot warts, raspberry heel or Mortellaro's disease. DD is an acute inflammation of the hairy skin of the foot, which is typically located between the dew claws and the cleft between the bulbs of the heel. Most of the lesions occur in the hind feet (24). An early DD lesion is a circumscribed (< 2 cm in diameter) epithelial defect. The following acute stage of DD is an ulcerative or granulomatous lesion with a white line surrounding the lesion. When the lesion starts healing, a scab forms and covers the lesion. Chronic lesions result in an alteration of the skin, which are characterized by proliferation and dyskeratosis (7). The exact cause and pathogenesis of DD is still unknown. However, spirochetes, particularly *Treponema* spp., are considered as the most likely cause of digital dermatitis, because they are the microorganisms most frequently isolated from DD lesions (16). Also other bacteria, such as *Campylobacter* spp. and *Fusobacterium* spp. have been isolated from DD lesions, although their exact role remains unclear (14). The prevalence of DD is determined in several countries or regions. In free stall housed cattle in the province Ontario the prevalence was found to be 22,9 % (6). In other

countries, such as Sweden and the Netherlands, a prevalence of 27 % (15) and 21,2 %, respectively, of DD was found (12). Note that the cows in Sweden and the Netherlands might have had access to pasture during some time of the year, which would lead to a decrease in DD cases.

DD is highly contagious and spreads via contaminated soil or slurry. An important risk factor for DD is therefore the accumulation of feces on floors or in bedding. Solid floors for example increase the risk of DD compared to slatted floors with scrapers (2, 17). Unsterilized hoof trimming equipment is also a known risk factor in the spreading of DD (22). Housing systems and hygiene are important factors that influence the spread of DD in a herd. Intervention at herd level can be therefore be helpful to prevent the spread of DD.

Footbaths are used to treat and control infectious claw diseases. The literature regarding the use of such footbaths in preventing and treating DD is scarce. Also, the use of footbaths are not always found to be beneficial. This can be due to the different solutions used or different types of lesions underlying lameness. Espejo et al., for example, found no association between use of a formaldehyde or copper sulfate footbath and the prevalence of lameness (8). Also, Amory et al found no benefits from using footbaths on farms in The Netherlands (1). On the other hand, there are studies that did find a beneficial effect of footbaths on the prevalence of DD. Teixeira et al. found a cure rate of 17 % for DD, when treating DD by using a footbath with formaldehyde twice weekly (19). Also other studies recommend a weekly footbath with a solution of 4 % formaldehyde for control of DD, when comparing formaldehyde with several alternatives, such as a multi-compound or sodium carbonate (11).

Many different solutions and combinations can be used in footbaths, depending on governmental regulations, for example, formaldehyde, copper sulfate, hypochlorite and other disinfectants. Formaldehyde and copper sulfate are the products most commonly used in Canada. A major disadvantage of formaldehyde is that it is carcinogen and therefore a hazard for the people that work with it. Formaldehyde is also proven to be very painful when applied to open wounds or lesions (14). A concern about the use of copper sulfate is pollution of the environment upon disposal (24). Because of these disadvantages, there has been some research investigating the efficacy of several alternatives to formaldehyde and copper sulfate, such as bleach or multicompound. For example, the use of copper sulfate in a 5 % solution was compared to the use of hypochlorite (bleach). Copper sulfate was found to be more effective than hypochlorite, when used after four consecutive milkings and resulted in less DD lesions and more healing ones (18). Alternatives such as quaternary ammonium compounds or peracetic acid were also found to have no effect on the cure or prevention of DD lesions (20).

Objective and hypothesis

This research has the objective to identify whether the use and management of a footbath is a risk factor for digital dermatitis for dairy cattle in the province of Alberta, Canada. The hypothesis is that farms with a good footbath management, have a lower prevalence of DD.

Materials and methods

For this research 51 dairy farms located in the province Alberta were visited during the period of January 1st 2011 until December 31st 2011. The farms consisted of at least 75 milking Holstein cows, had free stall housing and no access to pasture. These criteria were used, to ensure a representative selection of the population of Alberta dairy farms. The number of lactating cows was defined as the total number of lactating cows tested during that time period divided by the number of DHI tests. The number of lactating cows in the herd ranged from 56 to 470 cows.

The farms were also enrolled in the Alberta Dairy Hoof Health Project and were visited before hoof trimming was performed on the herd. The farmer decides which cows will be trimmed. For some farms this will be all the cows, but for some farms this will be only the lame cows. The reason for trimming only part of the herd is not recorded. The digital dermatitis lesions were determined and registered by trained hoof trimmers via the Alberta Dairy Hoof Health Project. The Hoof Supervisor® system, an automated lesion recording system, was used to register the claw lesions per cow.

Case definition: A case of digital dermatitis was defined as presence of one or more digital dermatitis lesions on any hoof during the study period.

Information about the footbath management was collected through a questionnaire with the farmer. Management of footbath includes the frequency of use, frequency of changing its contents and the product(s) used in the footbath. The following questions concerning the footbaths were included:

- How often do the cows walk through a footbath?
- How often do you change the contents of the footbath?
- Which products are used in the footbath and in what concentration?

The width, length and depth of the footbath were measured during the farm visit. The following criteria were used to define a good footbath and proper footbath management;

- Walk through footbath located at milking parlor exit or in the transfer alleys.

- Minimal size;
  1. Length: 3 m.
  2. Width: 80 cm.
  3. Depth: 15 cm.

- Products used;
  4. Solution of 2 to 5 % formaldehyde or a solution of 5 to 10 % copper sulfate

- Frequency of replacing contents, depending on the solution used;
  5. Every 300 cow passages for formaldehyde and every 200 cow passages for copper sulfate

  6. Frequency of use: at least one day (two milkings) per week.

These criteria were based on recommendations found in literature and expert opinion. None of the farms met all criteria, therefore it was not possible to exclude these farms. As a consequence every criteria was evaluated separately in the analysis. Because a lot of farms used copper sulfate and

formaldehyde in rotation or as a combination, the different maxima of cow passages for the products were not usable. Therefore the lowest maximum of 200 cow passages was used for both products as the proper amount of cows that would go through a footbath before replacing its contents.

Descriptive statistics

A cross-sectional study design was used. Farms were classified into a high and a low group according to the percentage of DD cases among the trimmed cows. The high percentage DD group consisted of farms with a percentage of DD at or above 25 %. The low percentage DD group consisted of farms with a percentage of DD below 25 %. The cut-off value of 25 % of DD cases was based on the prevalence of DD found in the province of Ontario, because housing systems and management would likely to be representative for those in Alberta.

The two groups were compared with respect to different factors concerning footbath management. The amount of criteria met was compared between the two groups. Because the data was divided as if it was a case-control study, odds ratios were calculated to define whether there was an association between the factor and the risk for DD.

Results

Of the in total 51 farms, one farm was excluded, because there was no hoof trimming data and therefore no data on the digital dermatitis cases. 48 farms used a footbath on a regular basis. One farm did not use a footbath at all and one farm only used a footbath in case of an outbreak.

The footbath dimensions are summarized in table 1. Of the 81 footbaths measured in total, four met the criteria for length, 25 met the criteria for width and 54 met the criteria for depth. None of the footbaths fit the combined size criteria mentioned in the materials and methods.

Table 1: Footbath dimensions

Length ≥ 3 m.	4
Width ≥ 80 cm.	24
Depth ≥ 15 cm.	52
Combined	0

In figure 1 the distribution of products used in the footbaths are summarized. This shows that copper sulfate and formaldehyde were the most commonly used products in the footbaths. The category 'other' consists of different combinations with zinc, soap, glutaraldehyde or an acidifying additive to copper or zinc sulfate. The concentrations of the solutions were not well recorded and could therefore not be used for the analysis. The frequency of use of the footbath was an average of five

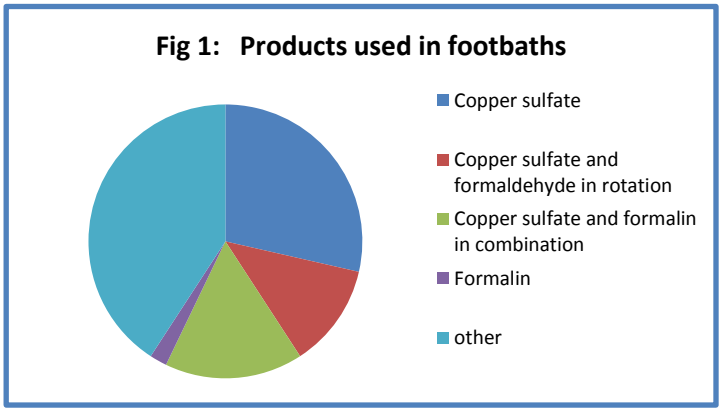

Figure 1: Products used in footbaths on 48 farms.

milkings per week (range 1 - 14). 43 farms used a footbath for two or more milkings per week and five farms used a footbath less than two milkings per week.

The frequency of replacing the contents of the footbath varied from daily to less than once a week. The average number of cows going through a footbath before the contents were replaced, was estimated by using the frequency of use of the footbath and the frequency of replacing its contents. On 28 farms more than 200 cows walked through a footbath without changing the contents. On 18 farms less than 200 cows walked through a footbath before the contents were changed.

The average percentage of DD cases of the trimmed cows was 22,3 % (range 0 - 71,3 %). Figure 2 shows the percentages of DD cases per farm for all 50 farms. The two farms that did not use a footbath on a regular basis, had a percentage of DD cases of 5,4 % and 71,3 %.

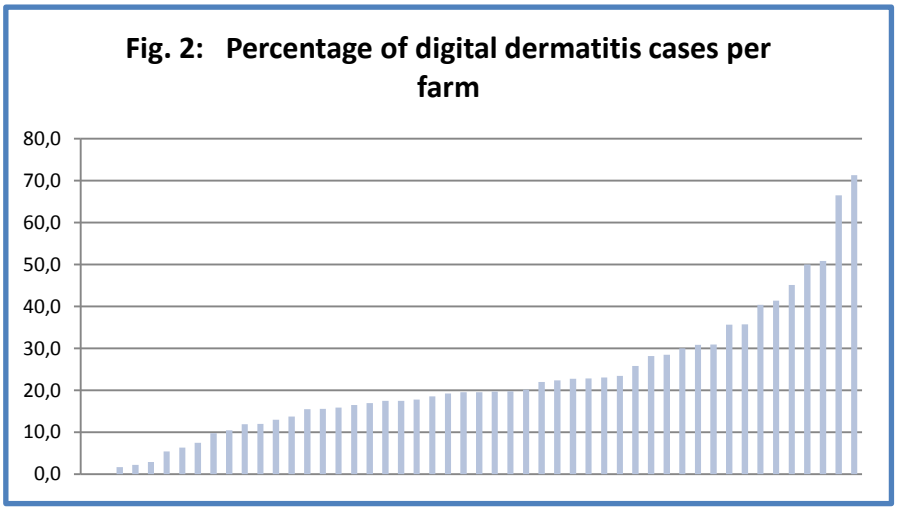

Figure 2: Percentage of digital dermatitis cases of the trimmed cows on 50 farms.

Descriptive statistics

The two groups based on percentage of DD cases, consisted of 14 farms in the high percentage DD group and 34 farms in the low percentage DD group. Of all the six criteria none of the farms met all the criteria. Figure 2 shows for the two groups how farms met a certain amount of criteria. The low percentage DD group has an average of 2.79 criteria met. The high percentage DD group has an average of 3.07 criteria met.

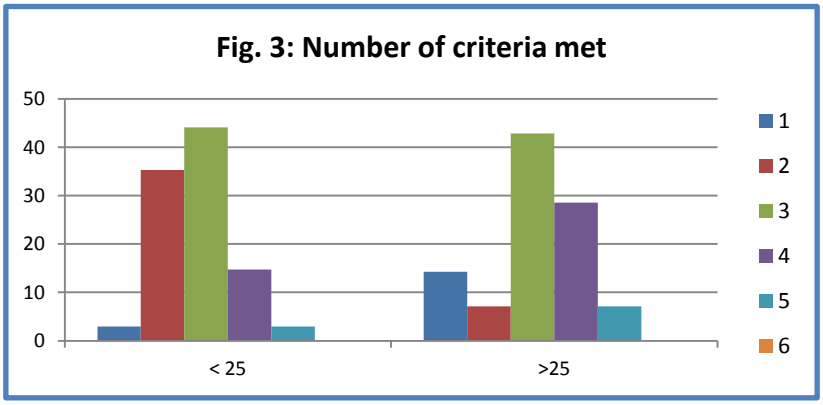

Figure 3: The number of farms that met a number of the criteria concerning footbath management.

Each of the variables regarding footbath management were evaluated for the two groups using 2 by 2 tables (table 2 to table 7). Odds ratios and their 95 % confidence limits were calculated for each factor and are summarized in table 8.

Table 2: Length footbath			
	< 3 m.	**≥ 3 m.**	
High DD ≥ 25 %	13	1	14
Low DD < 25 %	33	1	34
Total	**46**	**2**	**48**

Table 3: Width footbath			
	< 80 cm.	**≥ 80 cm.**	
High DD ≥ 25 %	10	4	14
Low DD < 25 %	24	10	34
	34	**14**	**48**

Table 4: Depth footbath			
	< 15 cm.	**≥ 15 cm.**	
High DD ≥ 25 %	5	9	14
Low DD < 25 %	10	24	34
	15	**33**	**48**

Table 5: Frequency of use			
	< 2 milkings per week	**≥ 2 milkings per week**	
High DD ≥ 25 %	2	12	14
Low DD < 25 %	3	31	34
	5	**43**	**48**

Table 6: Frequency of changing contents			
	> 200 cows	**≤ 200 cows**	
High DD ≥ 25 %	8	6	14
Low DD < 25 %	20	12	32
	28	**18**	**46**

Tabel 7: Products used			
	other	**coppersulfate and/or formaldehyde**	
High DD ≥ 25 %	3	11	14
Low DD < 25 %	17	17	34
	20	**28**	**48**

Table 8: Factors	Odds ratio	95 % confidence limits
Footbath length < 3 m.	0,4	**0,0 – 6,8**
Footbath width < 80 cm.	1,0	**0,3 – 4,1**
Footbath depth < 15 cm.	1,3	**0,4 – 5,0**
Frequency of use < 2 milkings per week	1,7	**0,3 – 11,6**
Frequency of changing contents > 200 cows	0,8	**0,2 – 2,9**
Other products than formaldehyde and/or copper sulfate	0,3	**0,1 – 1,2**

Odds ratios greater than 1, mean that there is an association between the factor and the risk for disease. An odds ratio below 1 mean that the factor is protective. This means that there is a decreased risk for disease due to this factor. An odds ratio close to 1 mean that there is no association between the factor and the risk for disease.

Based on these results it is not possible to say whether the factors concerning footbath management are risk factors for DD or not. Table 8 shows that the factors depth and frequency of use of the footbath are likely to increase the risk for DD, based on the calculated odds ratio. The factors length and the use of other solutions resulted in a protective odds ratio and would therefore decrease the risk for DD. The odds ratio for the width and the frequency of changing contents was close to 1, which means there is no association between this factor and the risk for DD. The last column of the table shows the 95 % confidence limits for each calculated odds ratio. For every factor the confidence limits contains 1, which means that the calculated odds ratios for the potential risk factors are not significant.

Discussion

The literature regarding footbath efficacy is rather conflicting. Both Espejo et al. and Amory et al. did not find the use of a footbath as a risk or protective factor for the prevalence of lameness (1, 8). However, several other studies did find a positive effect of the use of footbath on the prevalence of digital dermatitis (11, 19). It is difficult to determine an association between the use of a footbath and DD, because farms with a higher prevalence of DD are more likely to use a footbath than farms with a lower prevalence of DD. In this study use of a footbath versus not using a footbath could not be compared due to the small amount of farms that did not use a footbath. A cohort study design would be better to detect an association between the use of a footbath and digital dermatitis. Then farms would be selected on the use of a footbath and it would be possible enroll more farms that do not use a footbath on a regular basis. A disadvantage of such a study design is that there are still a lot of farm variables that need to be considered. In that case a experiment study would be better because the conditions of the study can be controlled.

None of the farms that did use a footbath regularly, met all the criteria for good footbath management. Also, none of the farms matched all the criteria for footbath sizes. The results from Holzhauer et al. also showed that a lot of the footbaths (50 %) were too small compared to the generally advised sizes, which were the same sizes that were used in this study (13). Since none of the footbaths were large enough, there was not enough statistical power to find whether footbath size is a risk factor for digital dermatitis. Length, width and depth were also evaluated separately, however these could also not be found as risk factors.

We encountered in our study a large variation in products used in the footbaths. Formaldehyde or copper sulfate were most commonly used, but also a lot of different combinations were used. Due to the large variation in used products, this could not be identified as a risk factor for DD. Percentages of the solutions were not well recorded and could therefore not be used. It is possible that the questions asked about product concentration were not clear enough or the farmers did not know exactly what concentration they used. Holzhauer et al. found that there was a large variation in formaldehyde concentration between farms, while they all stated to use a solution of 4 % formaldehyde (13). This can be due to miscalculations or insufficient mixing. In further research the

concentrations of the used products should be more accurately recorded or a sample of the solution should be taken for analysis.

The effectiveness of a footbath is largely dependent on management factors, such as the frequency of use and the frequency of replacing its contents. The frequency of replacing the contents varied widely in this study. The number of cows that can go through a footbath before the effectiveness of the product is reduced, is dependent on the solution used, manure contamination and the use of a prebath. Prebaths containing water can be used to reduce the contamination of the footbath. Some farms reported to use some kind of soap. However, it was not clear whether this was used as a prebath or not. Furthermore, use of a prebath or hosing the cows' feet before bathing was not recorded at all. The influence on the risk for DD could not be determined for the frequency of replacing the contents. Holzhauer et al. recommended to change the footbath contents after 300 to 320 cow passages for formaldehyde, based on the decrease of initial formaldehyde concentration (13). For this analysis a maximum of 200 cow passages was used for both copper sulfate and formaldehyde. However, only an estimate of how many cows went through a footbath before replacing its contents, was used. It is also possible that the maximum of 200 cows was not accurate to find an association with DD, because this can be different for copper sulfate or formaldehyde. Copper sulfate is known to be easily neutralized by organic matter (24). Manure contamination of the footbath will reduce the effectiveness of a footbath. Assessing the cleanliness of cows is a way to estimate the risk for contamination, which was not considered in this analysis. Besides the reduced effectiveness of the footbath, manure contamination can also be a risk for spreading of DD, since DD is easily spread via contaminated slurry (24).

The frequency of use of the footbath was not found as a risk factor for DD. It is possible that the baseline used was too small to find an association, since only five farms did not meet the criteria of at least two milkings per week.

The prevalence of DD on the farms could not be determined. The information gained in this study was the percentage of DD cases among the trimmed cows. Since not all farms trim all the cows at once, this is not the same as prevalence. The percentage of DD cases found was on average 22,3 %. The true prevalence is likely to be lower than 22,3%, because farmers are more likely to trim lame cows. A cut-off value for high percentage DD versus low percentage DD was determined at 25 %. It is possible that this value was not accurate to find any risk factors.

Conclusion

The objective of this study was to determine risk factors for digital dermatitis concerning footbath management. However, it was not possible to determine risk factors in this study. This was mostly due to small sample sizes and too much variation in footbath sizes and management. Since there was no consistency in the management of footbaths, this should be the focus of further research. Clear and understandable baselines for footbath management should be established and producers should be made aware of proper use of footbaths.

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