ABSTRACT

We compared the prevalence and severity of skin lesions on the hocks of lactating dairy cows in southern British Columbia, comparing 20 farms using three common bedding surfaces: sawdust, sand, and geotextile mattresses. Skin lesions were scored at five positions on the hock. For each position we noted if the lesion showed inflammatory attributes, and then assigned a severity score. Of the 1752 lactating cows scored, 1267 cows (73%) had at least one hock lesion. Of those cows with lesions, 87% had lesions on both legs, 76% had lesions on more than one location on the hock, and 78% had a lesion of at least moderate severity (i.e., evidence of skin breakage or an area of hair loss >10 cm²). Lesions were most prevalent on farms that used geotextile mattresses (91% of cows) and least common on farms that used sand (24% of cows). Moreover, lesions on cows from farms using mattresses were more numerous and more severe than those on cows from sand-bedded farms. The prevalence and severity of lesions on farms using sawdust was intermediate. Lesions also varied in relation to location on the hock. For farms using geotextile mattresses, lesions were more common and more severe on the lateral surfaces of both the tuber calcis and the tarsal joint. On farms using sawdust, lesions were common on the dorsal surface of the tuber calcis and the lateral surfaces of both the tuber calcis and the tarsal joint. Lesions were rare on all five positions for cows from sand-bedded farms. Among the 10 farms sampled using sawdust, we found a significant negative relationship between the length of the stall and severity of lesions. For cows with lesions, the number and severity of lesions increased with age.

(Key words: injury, comfort, welfare, bedding)

INTRODUCTION

Several factors are important in developing appropriate indoor housing for dairy cattle, including the provision of a comfortable bedded area that is well used by the cows and that minimizes the potential for bacterial infection. Although the issue of cow comfort is of great interest to producers, efforts to scientifically measure comfort are only just beginning (4, 8). Most scientists and nonscientists will agree, however, that housing systems that cause injuries to animals have significant shortcomings.

Several authors have identified aspects of housing systems that contribute to a high prevalence of foot and leg problems (3, 12), including lameness and leg lesions. Lesions on cattle are most likely to occur near areas of the body where there is some protrusion, such as at the joints including carpal, fetlock, tarsal, and hip. Injuries around the tarsal joint (hock) are common, and can range from a small area of hair loss to open sores, and, in some cases, swelling of the entire joint (2).

Unfortunately, there has been little experimental or comparative work to date on how stall features contribute to lesions. We are aware of only one previous study focusing on the problem of hock lesions in dairy cattle (11). These authors scored lesions on a number of farms in southern Ontario and found differences depending on the type of surface used in the free stall. Specifically, they found more lesions on cows bedded on solid rubber mats than on those bedded on geotextile mattresses. Work on pigs has found a relationship between the size of lesions and flooring surface used in the pen (1). The aims of the current study were: 1) to evaluate the prevalence and severity of skin lesions on the hocks of lactating dairy cows in southern British Columbia, and 2) to compare three common bedding surfaces used on farms: sawdust, sand, and geotextile mattresses.

MATERIALS AND METHODS

We scored 1752 lactating Holstein cows from 20 farms located in southwestern British Columbia. All farms but one (UBC farm located on Vancouver Island) were in the upper Fraser Valley. Farms were selected on the basis of ease of access, within the constraint that the
bedding system had been in place for at least 6 mo before our visit. The range in herd size (21 to 600 lactating cows) and farm management was, in our view, typical of the region.

Cows were individually identified by ear or neck tags. For 19 of the 20 farms, each with less than 300 lactating cows, an attempt was made to score each lactating animal. We needed to carefully examine both hind legs and cows were free to move, so some cows were missed, especially on larger farms. On the largest farm in our sample (farm 12 in Tables 1 and 2), we only attempted to score every second of the approximately 600 lactating cows.

Skin lesions on the hocks of the rear legs occurred in five positions: on the dorsal, lateral, and medial surfaces of the tuber calcis, and on the lateral and medial surfaces of the tarsal joint. For each position we noted if a lesion was present, and scored the severity of lesions as either 1 (area of hair loss less than 10 cm² with no evidence of skin breakage) or 2 (broken skin, dark scab, or area of hair loss greater than 10 cm²). We also noted if the entire tarsal joint was swollen. Left and right rear legs were observed. We noted if lesions occurred on one or both legs but only the most severe lesion in each of the five positions was recorded (i.e., one measure per cow for each of five positions). The severity of the most severe lesion on each cow was also noted.

Using these records, we calculated the following measures for each farm: 1) the percentage of cows with at least one lesion, and 2) the percentage of cows with lesions in each of the five locations. Including only those cows with at least one lesion, we also calculated: 3) the percentage of cows with lesions on both hind legs, 4) the mean number of locations on the hock with a lesion (1 to 5), and 5) the mean severity of the most severe lesion (1 or 2).

The farms we visited used three types of bedding surface (Table 1). Ten farms were classified as “sawdust.” These farms all used a deep layer (≥4 cm) of sawdust or wood shavings, although the consistency and source of this material varied among farms. The surface under this bedding was either earth, sand, sand and tires, or cement. Six farms were classified as using “mattresses.” All used commercially available geotextile mattresses (see reference 6 for full description) approximately 3 cm thick, and composed of a tightly woven polyester surface with a filling of shredded rubber. In four of these six cases the surface of the mattress was permeable; in the two other cases (farms 12 and 16 in Tables 1 and 2) the covering was plasticized, making the surface impermeable. In every case, a small amount of bedding (approximately 1 cm of sawdust/shavings in five cases, chopped straw in the sixth) was used on the surface of the mattress. On all farms, bedding depth

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1 Farms 1 to 10 used sawdust, 11 to 16 used geotextile mattresses, and 17 to 20 used sand.
2 Height to neck rail could be measured accurately only on those farms using mattresses.
3 On farm 20, cows had free access to two areas with very different bedding depths: one 5 cm, the other 20 cm.
was uneven, but the relatively small amounts of bedding used on the mattresses resulted in many patches with little or no bedding over the mattresses. The four remaining farms were classified as using “sand.” On one farm (farm 20 in Table 2), half of the available stalls had only a thin layer of sand (5 cm) with some areas of the cement base exposed and in direct contact with the cows’ skin. The three other “sand” farms all used a deeper layer (≥15 cm) of sand on a base of cement or earth. The consistency and source of the sand varied among farms, as did the use of tires to stabilize the bedding.

On the majority of farms, cows had not been given access to pasture during the preceding 6 mo. For the four exceptions (farms 1, 7, 15, and 17) cows had at least some access to pasture over the preceding month but were still using stalls. As the lesion scores for these farms did not differ in any consistent way from the other locations using the same bedding, these farms were included in all analyses. Removing these farms from the analysis does not substantially change the results reported below.

We measured characteristics of the stall including length, width, height (from top of bedding to neck rail), and curb height. Occasionally, different areas on the same farm employed slightly different stall dimensions. Therefore mean values are presented in Table 1. Bedding depth was measured in at least three different locations on each farm. Average depths greater than or equal to 15 cm were scored simply as 15 cm. An estimate of the frequency new bedding was added to stalls was obtained from the producer. For each cow we recorded the lactation number, and the length of the current lactation (days in milk) using farm or DHIA records when available.

### Statistical Analysis

Differences in the prevalence and severity of lesions between the 20 farms using different bedding types (2 df) were tested by analysis of variance (residual error df = 17). A posteriori differences among treatment means were tested using Duncan’s test. Our sample of 10 farms with sawdust-bedded stalls was adequate to test among farm correlations (Pearson’s r) between the lesion scores and stall and management characteristics on different farms (residual error df = 8). Data from these farms with sawdust stalls was also used to perform within-farm tests of the relationship between lesion scores and days in milk and lactation number. Lactation number and days in milk data were available for 904 cows. Cows with and without lesions were compared with an analysis of variance model that tested terms for farm (8 df), presence of lesions (1 df), and the
interaction (8 df) against the residual error (886 df). For 637 cows with lesions, differences in mean number of locations and the mean severity score were tested using a model that included terms for farm (8 df), lactation number (1 df), days in milk (1 df), and the three interaction terms (8, 8, and 1 df) (residual error df = 609).

RESULTS

Of the 1752 lactating cows scored, 1267 cows (72.6%) had skin lesions on the hock. Of those cows with lesions, 88.6% had lesions on both legs, 76.4% had lesions on more than one location on the hock, and 78.1% had a lesion with a severity score greater than 1.

Lesions were most prevalent on farms using the geotextile mattresses, and least common on those farms using sand (Table 2). On average, 91% of cows had lesions on farms using mattresses; these cows often had lesions in more than one location on the hock, and often lesions were of a severity score of 2. In contrast, only 24% of cows on sand-bedded farms had lesions, and these lesions were almost always on just one location on the hock and normally had a severity score of 1. The prevalence and severity of lesions on farms using sawdust was intermediate. Statistically, all three bedding groups differed from one another ($P < 0.05$) in the percentage of cows with lesions, and the number of locations on the hock with lesions. The mean severity score was significantly less on farms using sand than on those using mattresses or sawdust, but farms of the latter two types were not significantly different. Only 18 cows were scored as having swelling of the entire tarsal joint, but 17 of these cows were on farms using mattresses.

The prevalence of lesions also varied with respect to location on the hock (Figure 1). Lesions were rarely observed on the medial surface of the tarsal joint. Lesions were more common on the lateral and medial surfaces of the tuber calcis and on the lateral surface of the tarsal joint, especially on farms using geotextile mattresses. In contrast, lesions on the dorsal surface of the tuber calcis were more common on farms using sawdust or sand than on farms using mattresses. This same pattern of results was observed for the mean severity scores.

Figure 1. The percentage of cows with lesions at each of the five positions scored (dorsal tuber calcis, lateral tuber calcis, medial tuber calcis, lateral tarsal joint, and medial tarsal joint). Data are presented separately for farms using sawdust (10), geotextile mattresses (6), and sand (4). Bars with different letters differ at $P < 0.05$ as tested by ANOVA.

Among the 10 farms using sawdust, those using shorter stalls tended to have more severe lesions (correlation between stall length and lesion severity: $r = -0.65$, $P < 0.05$). Our sample of sand and mattress bedded farms was too small to allow for a meaningful statistical analysis among farms, but two observations warrant mention: 1) despite differences in management and stall dimensions among the six farms using mattresses, the prevalence and severity of lesions were remarkably similar; 2) one farm using sand bedding (farm 20 in Table 2) had a much higher prevalence and severity of lesions than the other three, perhaps because half of the available stalls on this farm had only a thin layer of sand. No comparison could be made between areas for this farm, as all cows had access to both areas.

For farms using sawdust stalls, we analyzed the effects of lactation number and stage of lactation (DIM) on the prevalence and severity of lesions. Cows with lesions were slightly older than cows without lesions ($2.1 \pm 0.04$ vs. $1.9 \pm 0.07$ lactations; $P < 0.001$). For cows with lesions, there were significant positive relationships between lactation number and both the number of locations with lesions and the severity score, but the interaction with farm was also significant. When we tested relationships separately for each farm, we found significant ($P < 0.05$) positive correlations between lactation number and the number of locations with lesions for five of nine farms, and significant positive correlations between lactation number and the severity score for five of nine farms. The other within-farm relation-
ships with lactation number were not significant, and we found no significant effects for days in milk.

**DISCUSSION**

More than 72% of the cattle scored in this study had lesions on the hock. Moreover, these lesions often occurred in several locations on the hock and were often of at least intermediate severity (i.e., score 2). We are aware of only one other comparable study (11) that recorded the prevalence of these lesions, and this earlier study also reported lesions on approximately 70% of cows scored. This previous study also compared the prevalence and severity of lesions on farms using two types of bedding: geotextile mattresses and solid rubber mats. The authors found that cows on mattress-bedded farms had slightly fewer leg lesions, and these lesions tended to be less severe. In the current study, we did not score farms using the solid mats (these are not commonly used by producers in the area) but found a higher prevalence of lesions (91%) on cows bedded on the geotextile mattresses than that reported in the earlier study. Although the scoring systems used in the two studies were not identical, the severity of lesions recorded in the current study were also higher than that noted in the earlier work (11). Differences between the studies may have been due to differences in management or stall features used on the farms included in the two samples.

We found a lower prevalence and severity of lesions on farms using sawdust-bedded stalls, and still lower levels on farms using sand bedding. Some care is needed in interpreting these results because farms differed in many other ways such as herd size. Experimental work will be required to determine if differences in lesions can be ascribed to differences in stall bedding when other factors are held constant. However, these comparative data suggest that certain types of bedding are more likely to result in hock lesions.

A number of features might account for the differences in lesions we report. With mattresses, the high prevalence and severity of lesions on the lateral surfaces of the hock may result from the leg rubbing on the surface of the mattress. It seems unlikely that the surface of these mattresses is sufficiently abrasive to cause lesions, but it is possible that friction between the leg and mattress allows for heat build up that reduces the strength of the skin. Piglets on rubber mats commonly suffer lesions on their front legs, and these are at least in part due to heat build up caused by friction (9, 10).

The differences between sawdust and sand-bedded stalls in these lateral lesions may be due to differences in the extent to which the rear curb was exposed. Sand is more likely to stay in the stall, and compresses much less when the cow lies down. For both of these reasons the potentially abrasive surface of the rear curb tends to be more exposed in sawdust stalls than in stalls filled with sand.

Sections of exposed curb may also cause lesions on the dorsal surface of the tuber calcis. This would explain the higher prevalence of these lesions on farms using sawdust than on those farms using sand, and would explain the lack of these lesions on farms using geotextile mattresses (as no curb is exposed in mattress bedded stalls). The depth of bedding did not correlate with lesion scores for sawdust-bedded farms, but the highest scoring sand-bedded farm was also the farm using an inadequate depth of sand (5 cm) in many of the stalls.

We found no evidence that lesions were more likely to develop later or earlier in lactation. However, many of the farms included in this study used similar housing for heifers, dry cows, and lactating cows in different stages of lactation. Differences in lesions might be more likely to occur when cows are housed in different ways at different stages of the production cycle. We found that cows with lesions tended to be slightly older than those without, but this effect was significant in only about half of the farms analysed, and reasons for an age effect were not clear.

There has been at least some research on appropriate stall dimensions for the lactating Holstein. For example, McFarland and Gamroth (7) recommend 2.3-m stall length for stalls with an open lungu space, and 2.4 m for stalls with a solid or slatted front barrier. Interestingly, many of the stalls we measured fell short of this recommendation, and we found that cows using the shorter stalls were somewhat more likely to develop lesions. Producers might favor shorter stalls to reduce building costs, or because they assume that cows are more likely to defecate in the stall when longer stalls are used. Some of the stalls were also narrower than the 1.2 m recommended for cows heavier than 500 kg (7), but we found no correlation between this or other measures of stalls and lesion scores. We also found no evidence that lesions correlate with the frequency at which new bedding is added to stalls. This is somewhat surprising because contact with wet bedding may make the skin less effective as a barrier, and wet, soiled bedding provides a medium for infection following some trauma to the skin.

The use of sand bedding for free stalls is popular because it provides a very poor medium for bacterial growth, and thus may help reduce the incidence of environmental mastitis (5). The low prevalence of skin lesions on cows using sand-bedded stalls might be due in part to the relatively dry, sterile nature of the me
medium and to the fact that sand cannot be easily scraped aside to reveal hard or abrasive surfaces.

Producers using sand bedding report good stall acceptance by cows, but more work is required to determine cow preferences for different bedding materials and differences in cow comfort relating to bedding type. One study found that cows were more likely to use, and spent more time lying in stalls with sand bedding, than those with a wooden floor (8). In one experiment in our laboratory, cows given the choice between three stalls identical in all respects except the type of bedding (sawdust, sand, and geotextile mattress) showed a strong preference for using the sawdust-bedded stall.

More work is required to determine how sawdust and mattress bedded stalls can be designed or managed in ways that reduce the prevalence of lesions to more acceptable levels. More work is required to determine the effects of stall features on other injuries such as those to the front knees, and more generally, the relationship between comfortable free stall design and the incidence of other problems such as lameness (3).

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