Prevalence of papillomatous digital dermatitis among culled adult cattle in the southeastern United States

Corrie C. Brown, DVM, PhD; Patrick D. Kilgo, MS; Karen L. Jacobsen, DVM, MS

**Objective**—To determine prevalence of papillomatous digital dermatitis (PDD) among culled adult dairy and beef cattle in the southeastern United States.

**Animals**—815 cattle examined during 4 visits to a slaughterhouse.

**Procedure**—The left hind foot of each animal was examined for gross lesions of PDD. Breed and sex of the animals were recorded. Lesions were examined histologically for pathologic changes and bacteria, especially spirochetes.

**Results**—22 of 76 (29%) dairy cattle and 29 of 739 (4%) beef cattle had gross lesions of PDD. Detection of lesions was not associated with sex of dairy cattle, but male beef cattle were more likely to have lesions of PDD than were female beef cattle. Histologically, acute and chronic lesions were seen; the most severe changes were localized to the stratum corneum. Spirochetes were seen in lesions from 31 of 51 (61%) cattle.

**Conclusions and Clinical Relevance**—Results suggest that PDD is common among culled adult cattle. Prevalence was higher in culled adult dairy cattle than in culled adult beef cattle. (J Am Vet Med Assoc 2000;217:928–930)

Papillomatous digital dermatitis (PDD) is an important disease of the feet of cattle that has emerged in the past few years. First reported in Italy in 1974, PDD has subsequently been reported from most parts of the world, including North America. Otherwise known as hairy heel warts, digital dermatitis, strawberry footrot, and footwarts, PDD is thought to be responsible for considerable economic losses. In fact, concern about the disease is so great that PDD was a major focus of the National Animal Health Monitoring System's Dairy '96 study, which used extensive surveys to gather data about the disease.

Papillomatous digital dermatitis begins as an ulcerated focus in the caudal interdigital space just below the heel bulb and progresses over weeks and months to a painful, proliferative, nodular mass. Two groups of treponema-like agents have been isolated from lesions, and animals with PDD lesions often have a humoral response to these isolated agents, suggesting that they are involved in lesion development. Evaluation of 16S rRNA sequences has suggested that 5 phylotypes of spirochetal organisms, all clustering within the genus *Treponema*, may be involved. Amplification of a 16S rRNA gene from lesion material has implicated an organism most closely related to *Treponema denticola*. However, the disease has not yet been reproduced through application of bacterial cultures, indicating that it may have multiple causes or require specific predisposing conditions.

The incidence of PDD among dairy cattle in the United States has been reported; however, these studies have relied on assessments by managers and retrospective reporting. The purpose of the study reported here was to determine prevalence of PDD among culled adult dairy and beef cattle in the southeastern United States through gross observation of lesions at the time of slaughter. In addition, lesions were examined histologically for bacteria and to determine the character of the inflammatory response.

**Materials and Methods**

Sample collection—Data and samples were collected during 4 visits over a 12-month period to a slaughterhouse in the southeastern United States. The slaughterhouse processed, almost exclusively, culled adult cattle. Each visit consisted of a 3-hour period during which every animal on the processing line (approx 200 animals/visit) was examined. Sex and breed (dairy vs beef) were recorded, and the left hind foot of each animal was removed and examined for any lesions in the caudal interdigital space or involving the heel bulb. Lesions in these areas were considered to be representative of PDD if they consisted of erosions or ulcers > 1 cm in diameter and had proliferative growth characterized by hyperkeratotic skin or hypertrophic hairs. Lesions grossly compatible with other diseases, including dermatitis interdigitalis (footrot) and erosio ungualae (heel erosion), were excluded. Lesions compatible with dermatitis interdigitalis were located deeper in the interdigital space, often had a gray exudate, and lacked any plastic changes. Lesions compatible with erosio ungualae consisted merely of erosions, occasionally with crusting and pyoderma that did not have any proliferative aspects.

Samples were collected from all left hind foot lesions grossly classified as PDD using an 8 mm biopsy punch. Samples were immersed in formalin and processed for histologic examination. Sections of each sample were stained with H&E, silver stain (Van Orden technique), or Gram stain (Lillie-Twort technique).

Statistical analyses—Season during which visits took place was recorded as fall (November), winter (February), spring (May), and summer (August). Data were analyzed by use of contingency tables and \( \chi^2 \) tests for independence. Values of \( P < 0.05 \) were considered significant.

**Results**

Eight hundred fifteen animals were examined, including 211 during the fall visit, 200 during the winter visit, 201 during the spring visit, and 203 during...
the summer visit. There were 739 beef cattle (618 females and 121 sexually intact males) and 76 dairy cattle (72 females and 4 sexually intact males). Prevalence of PDD lesions among dairy cattle (22/76; 29%) was significantly ($P = 0.001$) higher than prevalence among beef cattle (29/739; 4%). For dairy cattle, detection of PDD lesions (yes vs no) was not significantly associated with sex (male vs female; $P = 0.301$) or season ($P = 0.448$; Table 1). For beef cattle, detection of PDD lesions was significantly ($P = 0.017$) associated with season (Table 2), with prevalence highest in the fall (8%) and lowest in the winter (1%). Detection of PDD lesion was also significantly ($P = 0.017$) associated with sex in beef cattle, with lesions seen more often in males than females.

Histologically, active and resolving lesions were seen. Active lesions were characterized by zones of acute degeneration, necrosis, and inflammatory cell infiltration within the stratum corneum, usually associated with focal thinning of this layer, presumably because of fragmenting. In the tissues with the most severe changes, stratum corneum cells were swollen, misshapen, and less eosinophilic than normal. The most remarkable features of the chronic lesions were acanthosis, often with pseudoepitheliomatosus hyperplasia, and sometimes perivascular aggregations of mononuclear inflammatory cells in the dermis. In virtually all cases, there was marked thickening of the epidermis, with additional layers of stratum spinosum and stratum corneum. The stratum granulosum was decreased in thickness or absent in all but the most quiescent lesions. Parakeratotic hyperkeratosis was common.

Silver staining revealed organisms morphologically compatible with spirochetes in 31 of 51 (61%) lesions; organisms were seen in active and chronic lesions. In lesions with acute degeneration and inflammation of the stratum corneum, spirochetes could be found most reliably as coalescing streams in intercellular spaces between parakeratotic cells (Fig 1). In several cases, small numbers of spirochetes were found in the stratum spinosum and papillary dermis. In resolving lesions, spirochetes were most often seen in small pockets within the parakeratotic stratum corneum or at the surface, admixed with other bacteria.

Gram staining of lesions revealed a predominance of gram-positive organisms at the surface and a few pockets of gram-positive and gram-negative bacteria within foci of inflamed stratum corneum. Rods were predominant. None of the organisms stained with Gram stain were seen in tissues deeper than the stratum corneum.

**Discussion**

Results of the present study indicated an unexpectedly high prevalence of PDD among culled adult dairy cattle. Approximately 29% of the dairy cattle had gross lesions consistent with this disease involving the left hind foot, and even though PDD is more common in the hind limbs than in the forelimbs of cattle,10 this prevalence was still surprisingly high. However, results of the present study were skewed, because this particular slaughterhouse processed essentially only culled animals, and some of these animals may have been culled because of lameness.

We were surprised to find PDD lesions in 29(4%) beef cattle in the present study. Papillomatous digital dermatitis has been described primarily as a disease of dairy cattle, and few reports of the disease in beef cattle have been published.17 The underlying cause of PDD is believed to be related to management factors, and standing in wet slurry has been incriminated as a major contributing factor.18 Results of the present study suggest that factors involved in husbandry of beef cattle may also play a role in development of PDD.

For beef cattle in the present study, prevalence of PDD was highest in the fall and lowest in the winter, whereas prevalence of PDD did not vary with season for the dairy cattle. Researchers in California have reported that incidence peaked during late spring and early summer in the southern part of the state13.
and during fall and winter in the northern part. A survey of 4,516 dairy producers in 21 states found that new cases developed throughout the year, but most new cases developed during December through February.11

There are limited published descriptions of the histologic appearance of PDD lesions.6,7,18 For samples in the present study, the stratum corneum had the most severe lesions, including degeneration, inflammation, and fragmented swollen cells. Marked acanthosis, hyperkeratotic parakeratosis, and lack of stratum granulosum presumably were secondary to inflammation, and the accelerated rate of production by the basal layer was presumably responsible for the proliferation that is grossly so characteristic of PDD. Silver staining revealed spirochetes between parakeratotic cells of the stratum corneum and occasionally extending into the stratum spinosum and even into the papillary dermis.

References