

Claw diseases: The most common cause of dairy lameness diagnoses, frequencies and risk groups in a University herd

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Lameness is a worldwide problem in modern dairy production that affects animal behavior and performance.¹⁻³ In a recent NAHMS study⁴, the herdsman considered approximately 20% of dairy cows lame at some time during the year. The infectious disease digital dermatitis ("hairy foot wart") was reported to cause half of the lameness cases; the remaining causes are not being evaluated. Surveys from the UK^{5,6} found claw disease to be the primary cause of lameness, and white line abscess, sole ulcer and digital dermatitis to be the most common of these. The incidence of lameness and claw disease is greatly underestimated. Upon clinical examination Wells *et al.*⁴ found 2.5 times higher lameness prevalence and Rodriguez-Lainz *et al.*⁷ found twice as many animals affected with digital dermatitis compared to what the herdsman observed. To establish adequate diagnosis and actual frequency of foot lesions, the foot has to be thoroughly explored. Without appropriate foot restraint and positioning, this is a difficult and time-consuming chore. To accurately document a herd problem during routine foot trimming, the feet can be carefully examined and the lesions recorded on a simple form. Through this approach, subclinical lesions are also detected, which allows further analysis of foot health in the herd. For the herd, regular preventive foot trimming reduces lameness problems because subsequent claw diseases are prevented by promoting proper loading as well as detecting lesions at an earlier stage. Thus, the animal's performance is secured at an optimal level.

The aim of the present study was to investigate the dynamics of digital lesions over time as observed at regular foot trimming of the herd and at treatment of acute individual lameness cases. The relationships between claw disease groups (e.g. infectious and laminitis related), cow risk factors, and the possible influence on the animals' performance were of special interest.

Material & Methods

Herd data

The study was performed at a Washington State University Holstein dairy farm that included a 160-cow milking herd and a replacement herd. Approximately 30% of the milking herd were first-lactation heifers. Although not completely closed, only rarely were animals purchased from outside sources. The rolling herd average was about 11,000 kilograms per annum and the herd was a member of DHIA (Dairy Herd Improvement Association).

The animals were housed in covered free stalls with the open side of the building facing a concrete exercise and feeding yard. The free stalls were bedded with wood shavings and were maintained daily. The loafing areas were scraped daily. Dry cows and heifers close to calving were housed in covered pens with dirt bedding and a concrete feed apron. Two weeks before expected calving the heifers were introduced into the milking string. The heifers were calved in a separate box stall bedded with straw and the multiparous cows were calved together in a pen. The box stalls, which were situated close to the milking parlor, were also used for sick cows. The animals were fed a base TMR (total mixed ration) and concentrate, the amount of which was allocated by production and controlled by individual transponders. The animals were milked every 12 hours in a double-five "herringbone" parlor. Daily individual milk production was recorded.

Foot trimming

Previously only those animals chosen by the herds-men were trimmed, which was at irregular intervals. For the present study, a professional foot trimmer per-

formed maintenance foot trimming for all animals every fourth month. In association with the foot trimming, the digits were photographed and visually scored for claw lesions by the senior author. Acutely lame cows between trimmings were investigated according to the same procedure.

After the cow had been immobilized in a stand-up chute, each foot was restrained in a raised position. The whole foot was thoroughly washed with a brush and warm water containing a mild detergent to make areas of interest, especially the skin to horn junction of the bulbs, clearly visible. The claw was trimmed with an electrical grinder until a normal conformation was established (45 to 50 degree toe angle and a 75 to 80 mm toe length). The outer and inner claws were corrected to be as symmetrical as possible and the sole was unloaded by reducing the height of the central - axial area.

Records of infectious and laminitis related claw lesions

Using a high-resolution digital camera (Kodak DC 210), the foot was photographed from a palmar/plantar perspective.⁸ The digital images were transferred to a computer for archiving and for further evaluation and measurements.

Using a standardized scoring system, each foot was visually scored for lesions of the skin, heel, sole and white line⁹ both at cow-side and later from the photo. Based on a form frequently used by area professional trimmers, a coding system was developed. The aim was to devise a system that would not slow down the foot trimmer and could be used in future field studies together with foot trimmers. The codes with their labels are presented in Figure 1. In the abc-form, each character corresponds to a diagnosis related to a specific location of the foot. The lesion name is only descriptive and chosen to fit the system. For example bruise, or hemorrhage, means the same type of lesion irrespective of location and does not indicate the etiology. The form includes all feet but outer and inner claws are not distinguished from each other. Each lesion was scored for three levels: mild, moderate and severe.

Treatment of diseased claws

All moderate and severe digital dermatitis lesions (score 2, 3) were treated with local application of oxytetracycline (Terramycin) powder and wrapped for three days. Interdigital phlegmon was treated systemically with ceftiofur (Naxcel) for 3 to 5 days. Heel horn erosion (2,3), sole gap (2,3), sole ulcer, white line abscess, white line fissure (2,3), were treated by trimming away the diseased tissue to expose healthy tissue. White line abscess and white line fissure (3) were also flushed with iodine. Severe sole ulcers and abscesses were off loaded by applying a block to the healthy claw and, if the body temperature was elevated, systemic antibiot-

ics were administered. If not showing symptoms of a deeper active process, bruises of the white line, hemorrhages of the sole and minor fissures of the white line (1), gaps of the sole (1), and heel horn erosion (1) were not further explored beyond normal trimming. Keratinized skin projections ("warts") were not treated unless severe (3) or if they appeared together with dermatitis (2, 3). Sole ulcer, white line abscess and digital dermatitis were judged as being clinical if they were painful to pressure and the animal exhibited aberration in gait.

Analysis

Slight (1) lesions of all diagnoses except for white line abscess and sole ulcer were excluded in the analysis in this preliminary report. The prevalence was calculated as the percentage of cows with at least one foot affected with the specific lesion. Incidence rates were calculated for the 14-week period between the two trimmings based on the number of new cases that occurred among the animals that were present at both trimmings but unaffected at the first. The prevalence of different lesions and scores was categorized by foot factors (e.g., front, rear) and cow factors (e.g., parity 1, 2, 3>; days in milk in 100 day increments, and relative milk production). To evaluate the influence of clinical disease on milk production before and after treatment, the daily average production during a 5 day period before the trimming was compared to the same time beginning 5 days afterwards for diseased and treated and non-diseased animals. All analyses were performed using Statistical Analysis Systems.¹⁰

Results from the first two trimmings from the first year are included in this preliminary paper.

Results

The prevalence of claw lesions, by cow, at the two trimmings is presented in Tables 1 (a, b). The prevalence of clinical laminitis-related lesions (abscess and ulcer) decreased substantially between October and February, as did the frequency of sole hemorrhage and sole gap. The distribution of lesions per foot (fore, rear) pooled for the two trimmings is presented in Table 2. All lesions were more frequent in the rear feet. The difference was highest for warts and for white line abscess and least pronounced for heel horn erosion and white line bruise. In Table 3 the number of clinical lesions are presented as numbers of affected feet at first trimming, remission and recurrence, and the incidence of new lesions during the 14 weeks observation period. Missing are animals that were not present at second trimming due to culling. The highest incidence, 35 cases per 1708 cow-weeks, was found for digital dermatitis. Eighteen animals were treated for acute lameness between the trimmings. One animal was culled after being diagnosed

a = abscess of the white line. A purulent exudative process in connection to the corium of the sole and /or white line originating from a lesion of the lamellar corium and/or horn.

b = bruise of the white line. Blood imbibation of the lamellar horn, which may extend to the adjacent part of sole at the posterior wall.

c = corn of the interdigital space. Skin hyperplasia with fibrous tissue.

d = dermatitis of the digital skin. inflammation of the epithelium of the digital or interdigital skin with raw or granulomatoeous surface which is bleeding or prone to bleed,

e = erosion of the heel horn. Fissures, disintegration and/or circular defects of the heel horn in connection to the bulbs or interdigital space.

f = fissure of the white line. Detachment of the lamellar horn, causing a hole or loose wall without connection to the corium (white line disease).

g = gap of the sole. Fissure or disintegration of the sole horn vertical and/or horizontal with a keratinization of the corium (double sole etc.)

h = hemorrhage of the sole. Blood imbibation of the sole horn

p = phlegmon of the interdigital skin. Deep fissures with necrotic and/or sloughing tissue (foot rot)

u = ulceration of the sole. Open connection through the sole to the corium with out any keratinization

w = wart of the digital or interdigital skin. Proliferation of the epidermis including hyper- and parakeratosis.

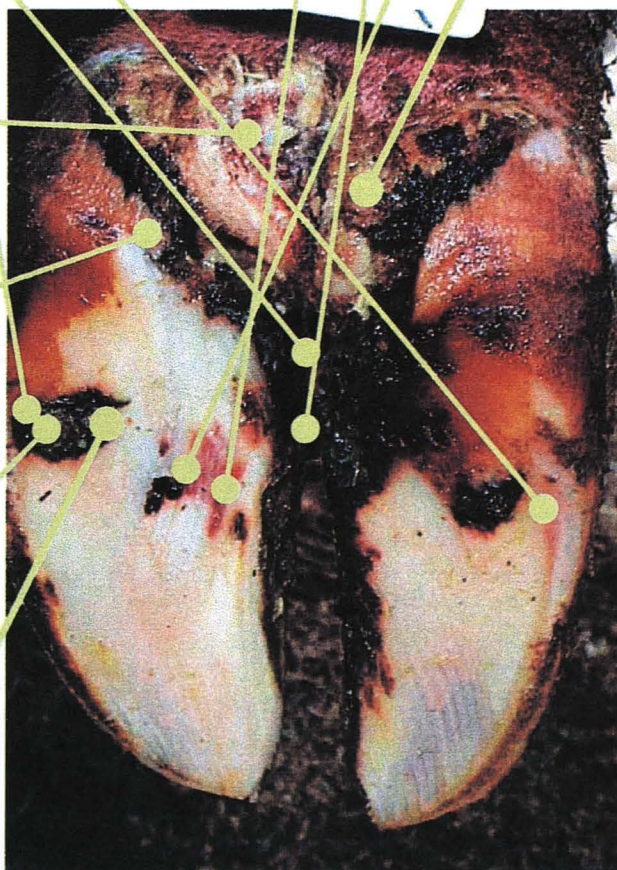


Figure 1. Definitions

Table 1a. Prevalence of cows with at least one foot affected with a infection related claw disease (October N=159, February N=134).

Diagnoses	October	February
Digital dermatitis*	29 %	26 %
Heel horn erosion	74 %	88 %
Corns	1 %	7 %

* Animals with this diagnosis most likely to show clinical signs

Table 1b. Prevalence of cows with at least one foot affected with a laminitis related claw disease (October N=159, February N=134). *Clinical symptom most likely occurs.

Diagnoses	October	February
White line abscess*	7 %	3 %
White line fissure	45 %	43 %
White line bruise	33 %	33 %
Sole ulcer*	11 %	9 %
Sole gap	28 %	20 %
Sole hemorrhage	48 %	28 %

* Animals with this diagnosis most likely to show clinical signs

Table 2. Percent distribution of claw lesions between fore and rear feet for each lesion and the relative risk for affecting rear feet compared to fore feet. Trimming in October and February (N=292).

Diagnoses	Freq. fore feet	Freq. rear feet	Relative risk
Dermatitis digitalis	19 %	82 %	4.3
Wart, proliferation	6 %	94 %	15.8
Heel horn erosion	44 %	56 %	1.3
Corns, interdigital	15 %	85 %	5.5
White line abscess	5 %	95 %	18.0
White line fissure	40 %	61 %	1.5
White line bruise	18 %	82 %	4.6
Sole ulcer	24 %	76 %	3.1
Sole gap	31 %	70 %	2.3
Sole hemorrhage	32 %	69 %	2.2

Table 3. Number of cows affected with "clinical" claw disease at first foot trimming, and recovered, persistent and missing when followed up at second foot trimming. Incidence, number new clinical claw diseases at second trimming of animals that were recorded healthy at first trimming, by 1708 (14x122) cow weeks. (N =159 at first foot trimming in October and N = 133 at second foot trimming in February).

Diagnose	Affected in October	Recovered	Persistent	Missing	Incidence to February
Digital dermatitis	56	39	4	13	35
White line abscess	13	5	1	7	2
Sole ulcer	15	6	3	6	8

with fracture of tuber coxae as well as dermatitis, 3 animals had interdigital phlegmon, 2 had white line abscess, 1 had sole ulcer and 11 had digital dermatitis, of which 4 were newly introduced heifers. Only the three cows with claw horn lesions had an earlier disease history of a similar nature and all improved by the following trimming in February.

The results in Figure 2 (a, b) show the prevalence of infection-related and laminitis-related claw lesions respectively within each parity for the two trimmings. Digitalis dermatitis and warts decreased with higher parity number while corns and heel horn erosion increased. The laminitis-related lesions had highest prevalence in animals of parity 3 and higher. The prevalence of white line fissure and to a less extent abscesses increased with parity while for the other lesions first calving heifers had higher prevalence than animals of second parity. Figures 3 (a, b) show the prevalence of digital dermatitis and sole hemorrhage respectively for the two trimmings by 100-day intervals in milk. The figures indicate a lower risk for the diseases in late lactation. The findings for sole hemorrhages were not consistent at the two trimmings.

Milk production was not improved immediately after treatment for those animals which experienced clinical claw disease at first foot trimming compared to those which didn't have clinical lesions.

Discussion

Lameness surveys reveal that claw diseases cause the majority of lameness.^{5,6} Of the acute treatments for lameness in the present study one of 18 acute cases was diagnosed as a lesion of the upper limb. Murray *et al.*

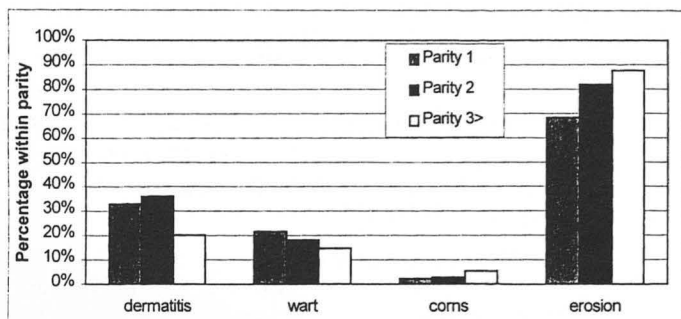


Figure 2a. Prevalence of infection related claw lesions by parity for the two trimmings (N=289).

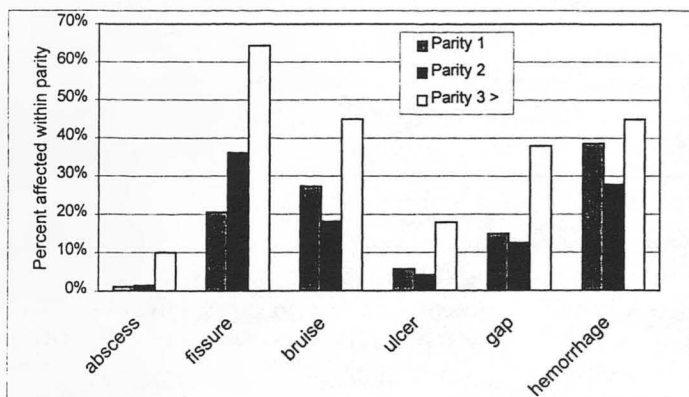


Figure 2b. Prevalence of laminitis related claw lesions by parity for the two trimmings (N=289).

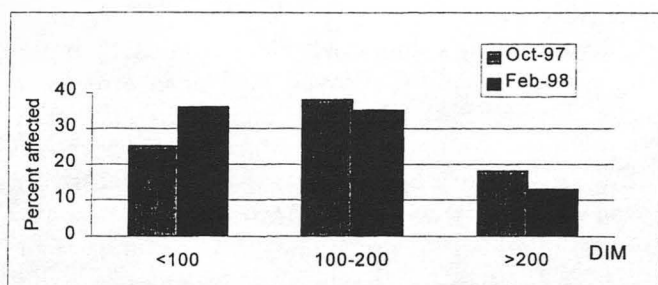


Figure 3a. Prevalence of digital dermatitis of score 2 and 3 by days in milk (DIM) at the foot trimming in October (N=159) and February (N=133).

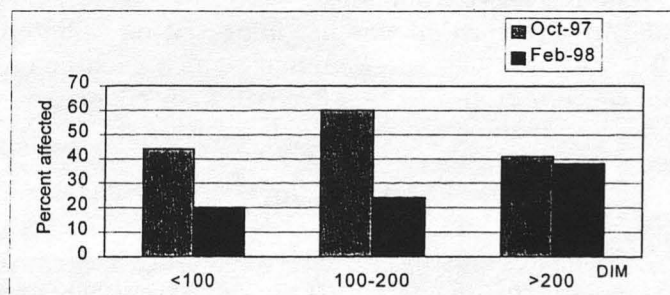


Figure 3b. Prevalence of sole hemorrhage of score 2 and 3 by days in milk (DIM) for the foot trimming in October (N=159) and February (N=133).

found that sole ulcer and white line abscess contributed 40% and 29% respectively, while digital dermatitis was found in 40% of acute lameness treatments made by veterinarians or by herdsmen in 37 herds. Although these figures do not relate directly to condition prevalence, they do reflect the average relative proportions of infection- and laminitis-related claw diseases in lame dairy cows. The relative distribution of these groups of claw diseases differed considerably in prevalence, incidence and among acute treatments in the present study. Clarkson *et al.*¹¹ found an annual average incidence of 56 out of 100 cows affected with lameness in the 37 investigated British herds but the range was large (11 to 170). In the NAHMS report,⁴ which estimated that approximately 20% of all annually lamenesses were treated, "hairy heel warts" accounted for approximately half of the treatments. Historically, the WSU herd had not experienced a significant lameness problem until just before the present study when digital dermatitis was recognized in the herd. Digital dermatitis was the most frequent clinical disease at both trimmings. Further analysis may support the relationship between different lesions that has been postulated by several authors^{12,13} but not yet clearly shown.

The higher distribution of lesions of rear feet compared to the front feet is a consistent finding in earlier studies and from practical experience. A more equal distribution between fore and rear feet for white line bruise and heel horn erosion is more likely to occur in free stalls than in tie stall barns.¹⁴ The association between claw disease and the exposure of feet to manure and concrete floors should encourage future improvement of dairy cows' environment.

Although the prevalence and incidence of digital dermatitis was high, the remission of diseased animals after treatment was very good. The follow-up of 43 diseased animals found 39 healthy at second trimming. That the four persistent animals had a disease history even before the study started is of special concern. In those treated animals that didn't appear at the second trimming, there were no observed recurrences as indicated by clinical cases. The animals were observed when the wrapping was removed and after three days the lesion already had a grayish keratinized epithelium, which was not prone to bleed and was not sensitive. The good response to topical antibiotic treatment and wrapping is in accordance with the literature and field experience.

A footbath was not provided in the present study. In a US study¹⁵ using footbath for treatment and control of digital dermatitis, the recurrence rate was reported to be substantially higher. In other studies, parlor spraying of feet using either antibiotics or antiseptic spray solutions has been found effective to control digital dermatitis when used frequently for long periods.^{16,17} The cost-benefit of alternative methods (individual ver-

sus herd treatment and antibiotic versus disinfectants) must be further evaluated. The prevalence of proliferative skin lesions (warts) and heel horn erosion increased between the trimmings, which is likely to be related to the recent introduction of digital dermatitis into the herd. Papillomatous digital dermatitis¹⁸ and heel horn erosion¹⁹ has been shown to increase with increased environmental wetness, which is likely to coincide with the winter months. This is the period that the NAHMS investigation found the risk of digital dermatitis to be highest. Most of the subclinical lesions associated with digital dermatitis (c, e, w) were not directly associated with lameness but indicate that the animal is at higher risk of acute lameness. Dopfer²⁰ was unable to predict whether a slight skin lesion would result in an acute ulcerative lesion or would remain in a persistent chronic or subclinical stage. Anecdotally, the acute digital dermatitis appears to be more frequent in newly infected herds after which the chronic subclinical forms become more prevalent. The increased prevalence of corns, which have been suggested as a secondary effect of interdigital skin irritation,²¹ is a logical sequel to the present dermatitis problem. This study will be extended to provide results over the long term that may help show more of the dynamic of these lesions.

Lameness and laminitis related lesions are most often recognized in multiparous animals.^{22,23} Subclinical laminitis, recognized as sole hemorrhages, has been observed more frequently in first calving heifers^{9,24-26} which is not in accordance with this investigation. The decrease of laminitis related lesions between the trimmings might have influenced the results, as subclinical laminitis was greater in these animals. The lowest prevalence in animals of second parity is an interesting observation which needs further attention.

The finding that digital dermatitis and warts were more frequent among animals of first and second parity agrees with Argaez-Rodriguez,³⁰ who found these animals to be more susceptible than older animals. This finding may indicate a higher resistance in animals that have been exposed previously. However, Dopfer²⁰ didn't find any association between the acute lesion and parity. The higher prevalence of heel horn erosion and corns in the older animals may be due to accumulated exposure, which results in more chronic lesions in these animals.

Claw lesions have been shown to have a higher prevalence during peak lactation.^{20,23,27,31} This was shown for digital dermatitis, the prevalence of which was lowest during the last hundred days of lactation. Sole hemorrhage has been shown to have the highest prevalence about 100 days after calving, which is in accordance with the trimming in October. The reversal in the pattern at the February trimming is probably a result of the general prevalence decrease in the animals of early and mid

lactation due to their being trimmed closer to calving, compared to the animals that began lactation earlier. Animals later in lactation usually show fewer signs as sole hemorrhages often decline spontaneously after peak lactation. The higher prevalence in the latter 100 DIM periods may be the residual chronic forms of the October lesions as the period between trimmings was about 100 days. Which intrinsic or extrinsic factors are important for the marked decrease among the freshened animals remains to be evaluated.

The prevalence of sole ulcer and white line disease together with subclinical stages of these diseases found at the first trimming indicates that laminitis is a herd-wide problem. Greenough²¹ suggests that a herd having a prevalence of sole hemorrhages greater than 25% or having more than 5% of the animals affected by lameness due to a laminitis-related disorder per year has a herd-wide subclinical laminitis problem.

Foot trimming is naturally more likely to prevent further development of lesions of the claw horn than those of the skin. Due to the multifactorial nature of laminitis, showing whether or not the foot trimming caused the decrease of the prevalence of white line abscess and sole ulcer in the present study is difficult. In an ongoing controlled Swedish study,²⁸ the prevalence of sole ulcer was lower in cows that were trimmed twice yearly compared to matched cows that were trimmed only once. Furthermore, Scharko²⁸ found first calving heifers which were trimmed in the fall achieved a higher yield (500kg) at their first lactation compared to their untrimmed herdmates.

Claw lesions are often indirectly associated with involuntary culling,¹ even if the reason from the herdsman's perspective most often is infertility.²⁹ Fifty-four percent of the cows with white line lesion, 20% of those with sole ulcer and 40% of digital dermatitis were culled before the second trimming and the primary reason given by the herdsman was either low production or infertility. Argaez-Rodriguez³⁰ found a prolonged time to conception time in animals affected with digital dermatitis and a negative although not significant effect on milk production. The lack of effect of clinical foot lesions on milk production during the selected period in this study may be because the animals were treated in close connection to the onset of clinical signs, which may before production was impacted. If this is a result of the foot trimming, then regular herd-wide could be justified on this basis alone.

Conclusion

The prevalence of claw lesions changed with time and cow factors at the two trimmings. A high prevalence and incidence of digital dermatitis was observed but the disease was successfully treated with local ap-

plication of antibiotics. The prevalence of white line abscess and sole ulcer decreased from the first to second trimming. The treatment was successful but required a long convalescence especially if the disease was of long duration prior to treatment. Dermatitis digitalis and warts were more prevalent in first and second parity while the other lesions were of highest prevalence from third lactation onwards.

Acknowledgments

The study was supported by the Swedish Foundation for International Cooperation in Research and Higher Education and WSU ARC Grant 3072-0858.

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