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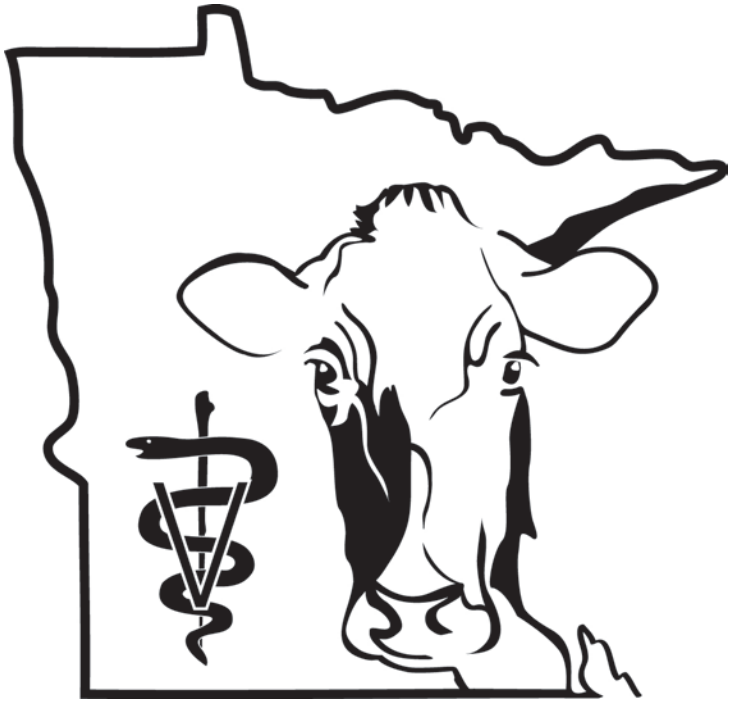

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LAMENESS OF DAIRY CATTLE: CONSEQUENCES AND CAUSES

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INTRODUCTION

Bovine lameness has become a health issue of considerable concern across the country. In problem herds where incidence is high lameness accounts for tremendous economic loss. Claw disorders associated with chronic subclinical laminitis are primary causes of lameness in most herds, followed by digital dermatitis, and foot rot. Early detection and appropriate treatment of lameness minimizes losses, improves outcome, and reduces animal suffering. Neglect not only increases losses but raises important animal welfare concerns.

Regular foot care and claw trimming are necessary health management procedures for today's modern dairy operations. Since the sheer number of lame cows in large herds would totally consume a veterinarian's time and effort, in many parts of the country these services are performed by on-farm health technicians or professional hoof trimmers. Despite this circumstance, veterinarians have an opportunity (if not a responsibility) to be well-informed about lameness conditions in order to provide functional advice on the treatment, management, and prevention of lameness problems.

INCIDENCE OF LAMENESS

A study of 37 farms in England and Wales over a 3-year period observed a mean incidence of 60 cases of lameness per 100 cows per year. Mean incidence of lameness during the winter (November through April) was higher compared to the summer (May through October). Ninety-nine percent of the lesions causing lameness occurred in the feet with 92% occurring in rear feet. Of lesions occurring in rear feet, 68% occurred in the outside claw, 12% in the inner claw, and 20% on the skin. In front feet, 46% of lesions occurred on the inside claw, 32% on the outer, and 22% on the skin. The most common lesions were sole ulcer and white line disease which accounted for 58% of lesions. Digital dermatitis was next accounting for 8% of lesions followed by foot rot, interdigital hyperplasia (fibroma or korns), and foreign body which each amounted to 5%.

Data on lameness reported to DHI in 1995 for the University of Florida Dairy Research herd was similar to that observed in the above study by Ward. The Dairy Research herd data indicated that there were 178/346 (51 cases/100 cows) clinical lameness events affecting 120 (35%) cows; 27/120 had more than one clinical event. In contrast to

the above study, the majority of cases in the University Florida herd occurred during the summer months of June through November. Claw disorders (sole ulcers and white line disease) accounted for 63% (113/178) of reported cases whereas digital dermatitis and foot rot were identified as causes for 20% (35/178), and 17% (30/178) of cases.

ECONOMIC LOSS ASSOCIATED WITH LAMENESS

The economic loss incurred as a result of disease arises primarily from the consequences of disease and not the cost of treatment. British researchers estimated that sole ulcers were responsible for the greatest economic loss ($627/case, converted to US dollars assuming the value of the British pound at 1.6 to 1 US dollars), followed by digital diseases such as white line disease and sole abscess which accounted for losses of $257/case. Digital dermatitis and foot rot accounted for smaller, but significant losses at $128/case. Lower milk yields, reduced reproductive performance, higher involuntary culling rates, discarded milk, and the additional management effort required to care for lame cows accounted for the majority of economic loss. Application of these same figures to the University of Florida's herd of 346 cows computes a loss due to clinical lameness during the 1-year study period of $58,266.00. Calculations of economic loss on an individual cow basis, place costs per lame cow at $327, or $168/cow in the herd.

Guard reports similar but slightly lower rates of economic loss based on clinical observation and records of lameness in New York dairy herds. Based on an incidence rate of 30 cases/100 cows/year, a fatality rate of 2%, an increase in days open of 28 days, and costs for treatment and additional labor of $23/case, he estimated a cost of $9000/100 cows/year. Cost per clinical case in Guard's example is $300/lame cow, or $90/cow in the herd. The estimates of loss per cow is similar for both studies. The difference in costs per cow in the herd is largely a function of the incidence. Clearly, lameness is one of the most costly of health problems affecting dairy cattle.

THE BIOMECHANICS OF WEIGHT-BEARING

Ninety percent or more of lameness in dairy cattle involves the foot. Of that involving the foot, most involves rear feet, particularly the lateral claw. This pattern of lameness is indicative of the fact that more than just nutrition and feeding management errors are responsible for lameness disorders. At least one plausible explanation exists from the studies on weight-bearing.

The biomechanics of weight-bearing in cattle are eloquently described in a book entitled "Cattle Footcare and Claw Trimming" by E. Toussaint Raven from the Netherlands. Following years of study and observation, his insight on weight-bearing and the likely effect of housing conditions (hard floors) on foot problems has added much to our current understanding of lameness, particularly as it relates to laminitis and claw disease.

The hind legs of the cow are connected to the pelvis through a ball-and-socket joint. This creates a fairly rigid skeletal structure for support of the rear quarters and legs of the cow. Viewing this anatomical arrangement from the rear, in an animal standing squarely on its feet, one can visualize weight distribution as being essentially equal over all 4 claws of the rear feet. However, during movement the distribution of weight within and between claws changes. Studies by Raven show these changes in distribution of weight to be greatest for outside claws. Despite movement, load-bearing on the inside claws is more even. Outside claws automatically and continuously correct for ever-changing weight load. However, it's this circumstance of ever-changing weight distribution that is believed to be the major reason for accelerated hoof growth and a higher incidence of claw disorders involving the outside claw.

The situation for front feet is quite different. First of all, there is more flexibility in the anatomical arrangement of the skeleton and soft tissues of the shoulder. Front legs are not connected to the upper body through a ball-and-socket joint. Instead, front legs are connected to the torso by tendons and ligaments that tend to cushion the effects of variable weight distribution between the claws. As a result the bio-mechanical forces associated with variable weight distribution are less pronounced in front feet and disorders leading to lameness less frequent. However, when lesions do occur they are more commonly associated with the inside claw.

Confinement on concrete or other hard surfaces enhance the physical effects of excessive load-bearing on feet, whereas housing on earthen surfaces dampens these effects. The practical significance of which is the observation of cattle (especially heifers) moved from pasture to confinement that experience lameness due to a physical/mechanical form of laminitis. These physical effects are further complicated by the fact that the unyielding nature of hard-flooring surfaces tends to irritate the corium and accelerate hoof growth. Excessive hoof growth (particularly of the outside claw of rear feet) leads to overgrowth and eventually overloading of the affected claws. The end result is a greater likelihood of developing claw disease.

Confinement on hard surfaces is sufficient alone to cause a mechanical form of laminitis that, with subsequent claw overloading, could lead to claw disease. However, add to this complications incurred from metabolic or systemic disease and the severity (as well as incidence) of laminitis and claw disease escalates dramatically.

LAMINITIS (CORIOSIS) AND ITS RELATIONSHIP TO CLAW DISEASE

Simply stated, laminitis is an aseptic inflammation of the sensitive lamina (corium) of the foot. Since more than just the laminar portion of the corium is involved, coriosis is considered by some a more accurate term. To most, however, laminitis is founder.

The pathogenesis of laminitis is believed to be associated with a disturbance in the micro-circulation of blood in the corium which leads to breakdown of the dermal-epidermal between the hoof and pedal bone. Rumen (lactic) acidosis is considered to be a major

predisposing cause of laminitis and presumably mediates its destructive effects through various vasoactive substances released in coincidence with development of rumen acidosis. These vasoactive substances initiate a cascade of events in the vasculature of the corium including increased blood flow, thrombosis, ischemia, hypoxia, and arterio-venous shunting (which directs the flow of blood directly from artery to vein). The end result is edema, hemorrhage, and necrosis of corium tissues.

By virtue of its anatomical location between the hoof shoe and pedal bone the corium is particularly vulnerable to inflammatory insult. Any increase in size of the corium due to fluid accumulation (blood and lymph) will increase pressure, pain, and tissue damage. Bound on one side by the hoof wall and the other by the pedal bone inflamation of corium tissues often leads to swelling at the coronary band.

Destruction of the dermal-epidermal junction has particular consequences as it permits laminar separation. As the laminae separate the pedal bone begins to "sink" within the hoof horn shoe. The result is compression of the corium between the pedal bone and sole which sets the stage for the development of sole ulcers. In some cases this "pedal bone sinking phenomenon" involves severe rotation of the toe of the pedal bone downward toward the sole. If compression of the corium by the toe is severe enough a toe ulcer may develop. If, on the other hand, sinking of the pedal bone is such that the rear portion sinks furthest, compression and thus sole ulcer development will most likely develop in the area of the heel-sole junction (known by some as the "typical site" or the site most commonly associated with the development of sole ulcers).

SOLE ULCER

A sole ulcer is described as a circumscribed loss of the horny sole which exposes the corium. Sole ulcers tend to be one of the most debilitating of lameness conditions affecting dairy cattle. Appearance of the lesion will vary according to it's maturity. Early ulcers may appear as nothing more than a circumscribed area of fresh tissue that may be uncovered in the process of hoof trimming. More mature or long-standing sole ulcers may be covered initially by rough, irregular horn tissue that when pared away exposes granulation tissue which bleeds freely if damaged.

As indicated previously, laminitis is thought to be a major predisposing cause of sole ulcers. The combination of excessive hoof horn formation, displacement of the pedal bone, the production of softer solear horn, and the accelerated growth of hoof horn on the anterior and abaxial hoof walls predispose the lateral claw to excessive loading, wear, and weight-bearing at the "typical site". The additional strain and pressure applied to the heel/sole region (or toe in the case of toe ulcers) exacerbates dysfunction of the underlying corium and leads to development of the lesion. Treatment requires removal of the necrotic (dead or decaying) horn tissue followed by elevation of the affected claw with a footblock attached to the unaffected claw. All healthy horn tissue should be left in place.

Regular hoof trimming is an important factor in lowering the incidence of sole ulcers. Periodic trimming maintains appropriate weight-bearing on all claws and reduces the potential for excessive claw-loading and sole ulcer development.

WHITE LINE DISEASE AND SOLE ABSCESSES

Areas of hemorrhage and necrosis of the corium are often most noticeable and severe in the white line region of the sole. This corresponds to the weight-bearing region of the claw. Because it is an active area of hoof formation it is highly vascular, and a frequent site for hemorrhage during bouts of laminitis. These areas of hemorrhage are not visible during the acute stage of laminitis. Instead, they gradually rise to the surface of the sole over a period of weeks. At this point they become visible and useful as indicators of disease of the corium (subclinical laminitis).

Another outcome of veterinary significance associated with laminar necrosis is the formation of subsolar abscesses (otherwise known as white line disease). Most of these abscesses are sterile but nonetheless troublesome as they cause acute lameness in affected animals. However, abscesses tend to occur at higher incidences in animals suffering laminitis via another mechanism - penetration of the white line by foreign material from the environment. There a couple of reasons for this: 1) dermal-epidermal separation and distorted claw growth which results in widening of the white line, and 2) hoof horn formed by the diseased corium is softer and thus more subject to wear and penetration by foreign material from the environment. As a consequence, the incidence of white line disease increases in herds suffering laminitis.

Regardless of how the abscess develops, it is treated by pareing and drainage. For abscesses which develop as a result of penetration through the white line or sole, establishing drainage through the original site of the contaminant's entry is the desired approach when possible. The site of entry can usually be visualized as a dark area packed with extraneous debris on the surface of the sole. Visibility of these is often improved following cleaning and/or pareing away of the superficial layers of the solear horn. Once the entry site is located careful pareing out of the tract leading to the abscess is required until drainage is accomplished. Care should be taken to establish drainage, however minimize peripheral damage. The hole established for drainage of the abscess may be packed with small cotton ball soaked in iodine or other antiseptic solution. Many animals will show immediate improvement, whereas others in which abscessation was more extensive may take several days to improve. There is no need for antibiotic therapy unless the infection extends to deeper tissues of the foot as evidenced by swelling and severe lameness.

Sole abscesses are extremely painful. For severe cases, pain can be alleviated through the application of a foot block to the unaffected claw of the affected foot as described for treatment of sole ulcers. Elevation of the damaged claw suspends weight-bearing, reduces discomfort,and promotes recovery. Blocks will eventually fall off (or wear off) after a period of several days to a couple of weeks. Foot blocks in common use are Technovit, Dr. Jorgensen Labs and Cowslips, manufactured by American Giltspur.

HOUSING AND ENVIRONMENTAL CONSIDERATIONS

The dairy cow evolved as a land animal and not one adapted to standing on hard, abrasive surfaces. In today's modern confinement systems, cows spend a majority if not all of their time on concrete. The unyielding nature of concrete surfaces encourages lameness through direct and indirect effects on laminitis and related claw diseases in cattle. Furthermore, confinement restricts exercise. Cows just don't have the same freedom to move about as they once did in traditional housing systems where cows had access to pasture. Options for resting are limited to a free stall or the alleyway. Considering the foregoing discussion and what would be most natural for the cow, it's not hard to see why confinement generally increases feet and leg problems.

Standing or Lying Time

A variety of housing and management factors appear to influence the amount of time cows will spend standing verses lying down and resting. Obvious considerations are availability of stalls, stall design, and amount of bedding. Leonard evaluated the effect of lying time on first-calf heifers. He found that heifers which spent 10 or more hours per day lying down had significantly better claw health than those that spent 5 hours or less lying down per day. Heifers may be slower to lie down in free stalls for a number of reasons a couple of which are fear of aggressive behavior by mature cows and unfamiliarity with free-stalls. One additional consideration is the number of stalls available. When stall numbers are equivalent to or less than the total number of animals in the barn, timid heifers may have less opportunity to rest. Blowey recommends that dairies have a least 10% more free-stalls than cows to allow for more choice and encourage lying time.

Free-Stall Design and Comfort

The incidence of lameness is higher in freestalls (35%) compared with straw yards (8%). Similar observations were made by Ward who found that large herds with free-stall housing experienced more lameness compared to large herds where cows were housed in straw yards. A comfortable stall encourages resting, thereby improving cow comfort and overall performance. British recommendations for Holstein cattle call for a free-stall 8 feet long (7 feet 6 inches for two facing rows) by 4 feet wide with a brisket board (15 inches high) located 5 feet 8 inches from the stall curb. Excessive curb height (over 6 inches high), inadequate bedding of the freestall, and insufficient lunge space have all been related to an increase in herd lameness.

Herdsmanship

A study by Clarkson, et al. found that farmers who allowed their cattle to walk in single file had less lameness compared to farmers that pushed their cows to the parlor and back. Clackson and Ward found that rushing cattle over rough flooring surfaces led to a greater potential for damage to the corium and a greater incidence of lameness. Cows should be allowed to move at their own pace over hard and rough surfaces. Movement at the herdsman's pace increases foot problems and injuries from falling or slipping.

Concrete

Concrete, depending upon how it is formulated and mixed, is capable of creating an extremely abrasive surface for cows' hooves. New concrete is more abrasive than old, and wet concrete is up to 83% more abrasive than dry concrete. Studies show that cattle hooves may wear more than they grow during the first 2 months on concrete. Animals on wet concrete suffer doubly; first, because of the increased abrasiveness associated with wet concrete and secondly, because moisture softens the hoof horn thereby permitting an increased rate of hoof wear. A further cause of increased hoof wear occurs from crowding or rushing cattle which results in increased hoof wear from twisting and turning on rough abrasive flooring surfaces. For this reason, the proper design of facilities which incorporates ideas for easing cow movement thereby reducing rotational forces on hooves are important housing considerations.

On the other hand, smooth concrete reduces wear and contributes to hoof overgrowth. It is also slippery and predisposes to injury, usually of the upper leg, from falling. Grooving the surface of smooth concrete floors increases traction, and while costly (as much as $.40 to $.60/square foot with a mechanical groover), is considered by most well worth the expense to prevent injuries from falling.

Some operations use rubber belting (conveyor-type) along feed mangers and in alleys or walkways to and from the milking parlor. However, if stalls are not cool or comfortable places for cows to rest, cows will lie on the belts and thus block access to the feedbunk. Rubber belts can be slippery walking surfaces when wet. Grooving the belts (belts without reinforcing wires) helps reduce slipping injuries. Despite a few minor drawbacks, rubber belting is a flooring surface modification that improves cow and foot comfort. They are not a substitute for a poorly designed stall. In herds where it does not work well it is often because other cow comfort issues (poor stall design, heat stress, etc.) have not been properly addressed.

Others attempt to avoid the negatives of concrete by using feed barns with adjoining dirt lots. The disadvantages of dirt lots in warm humid climates is that they usually lack shade and become muddy in wet weather. Further, while cows may be inclined to use these lots during evening or overnight hours, feeding patterns and increased relative humidity during these same periods, increases the likelihood of hyperthermia and reduced performance. Cow cooling is a 24-hour-a-day process during periods of intense summer heat and humidity. Clearly, adjoining dirt or grass lots can reduce the mechanical impact of hard surfaces on feet and legs, but maximum use (or benefit) will likely be seasonal.

DIGITAL DERMATITIS

Digital dermatitis was first described in 1974 by Drs. Cheli and Mortellaro from Italy. In the United States the condition is known by a variety of different terms including: hairy heel warts, digital warts, strawberry foot, raspberry heel, verrucous dermatitis, Mortellaro or Mortellaro's disease, papillomatous digital dermatitis, and digital dermatitis. Regardless

of the terminology applied to this condition, it is recognized worldwide as a frustrating, if not serious, health problem. Most perplexing in recent years has been the dramatic increase in incidence of this disease. Even more troubling, is the fact that the precise cause (or causes) and factors which predispose to its occurrence in herds, are largely unclear.

Recent survey data from California cited the following as risk factors for digital dermatitis: 1) large herds, 2) herds with predominately Holsteins, 3) herds with corral housing in winter (muddy conditions prevail at this time), and 4) herds using footbaths. Others have theorized that wet muddy conditions favored the propagation of this disease in herds, however until this survey there was little to substantiate this view. More obvious has been the observation of a higher incidence of digital dermatitis amongst herds which purchased cattle or had heifers and young stock raised off-farm for return at a later date. There remain a few closed herds that have never developed a case of foot warts. Finally, it's of more than just casual interest that footbaths were recognized as a significant risk factor. These are particularly difficult as well as costly to manage properly in large herds.

Early approaches to therapy in the United States included surgical excision, footbaths and/or topical treatment with various disinfectants and caustic chemicals, cryosurgery (freezing), and electrocautery (burning). More recently, topical antibiotic treatment under a bandage has become a popular method to treat individual animals; specifically, topical treatment with cotton balls or gauze soaked in oxytetracycline hydrochloride or in a lincomycin/spectinomycin combination product under a bandage. Most cows are remarkably improved within 24-48 hours. Bandages can be removed 3 to 5 days following application.

There is surprisingly little controlled data to substantiate the use of footbaths for control of lameness, let alone footwarts. When used as the sole method of treatment or control, effectiveness varies considerably. Most report little or no benefit from the use of copper sulfate for treatment of footwarts. Recent marketing of a pH adjusted copper sulfate product has shown better results but may not be sufficient alone. Formaldehyde at a 3-5% concentration appears effective for some but not for others. The use of formaldehyde is further complicated by concerns for worker safety. Several states have, or are, placing restrictions on the use of formaldehyde in footbaths.

Tetracycline or oxytetracycline at rates of 1-10 grams/liter of water have been advised and are reported to be effective if managed properly. Still others prefer to medicate their footbaths with a lincomycin/spectinomycin (LS-50) combination product or lincomycin alone, at the rate of .1-.5 g/liter of water. A veterinary practitioner from England reports successful control of footwarts with a single monthly passage through a footbath containing 5-6 g/liter of oxytetracycline (Pfizer) or 150 g LincoSpectin-100 (Upjohn) in 200 liters of water. The major concern with antibiotics in footbaths is residues from direct contamination (through splashing) of the udder and teats or from oral ingestion of footbath solutions by cows.

A series of trials conducted in Florida have found topical spray treatment with either oxytetracycline or lincomycin very effective at managing digital dermatitis. Test of an adjusted copper sulfate formulation (Hoof Pro Plus) as a topical spray was demonstrated

to be effective as well although not quite as effective as the antibiotic preparations. Topical spray treatment has several advantages over the footbath approach: 1) less expensive, 2) higher concentration of drug can be applied directly to the lesion, 3) less potential for neutralization from organic material, and 4) less potential for antibiotic residue from ingestion by the cow. See Appendix I for suggestions on spray treatment formulations.

FOOT ROT

Foot rot is a contagious disease of cattle characterized by the development of a necrotic lesion in the interdigital skin. The accompanying cellulitis extends into the soft tissues of the foot causing swelling and lameness. The lesion has a typically foul odor which some find helpful in distinguishing it from other conditions. Incidence appears to be higher during the winter months and in confinement-housed cattle.

Recently a new more severe form of the disease has been observed. It has been termed "Super Foul" or "Super Foot Rot". It is described as a fulminating infection that causes extensive interdigital tissue damage and swelling that extends well up the leg. Unless treatment is approached early and aggressively results are not favorable.

Environmental factors associated with these disorders may include housing conditions which require cows to walk through or stand in manure slurry for extended periods. Since the causative organisms are believed to originate from the gastrointestinal tract of the cow it would be reasonable to expect that manure management would be helpful to reducing the occurrence of the disease. Removing extraneous debris from walkways and alleyways to avoid interdigital skin lesions and keeping cattle habitat as dry as possible are believed to major considerations in the prevention of foot rot problems.

Treatment generally requires systemic antibiotic therapy. Treatments of choice are Naxcel (Ceftiofur Sodium), Penicillin, Albon (Sulfadimethoxine), and tetracyclines (extra-label in dairy cattle). Some prefer to simultaneously treat the interdigital lesion as well. Various antiseptic type products may be used as topical treatments. Bandaging of the foot is optional. Regardless, the secret to success is early detection of the disease.

SUMMARY

Feet and leg problems constitute a major health problem for many dairy herds. The causes and/or predisposing factors are many and include: nutrition and feeding, housing and environment, concurrent disease, management factors and genetic influences. The majority of lameness ($> 90\%$) involves the foot. Claw diseases (sole ulcers and white line disease) are a primary cause of lameness in most herds and are predisposed by laminitis and confinement on concrete. Foot rot and digital dermatitis are diseases with an infectious component responsive to antibiotic treatment, particularly when identified early-on in the course of disease. Manure slurry, mud, and otherwise wet conditions seem to favor the occurrence of these diseases, however specific data to support these thoughts is limited.

SELECTED REFERENCES

1. Blowey RW: Interdigital causes of lameness. International conference on bovine lameness, June 26-30, 1994, p. 142-153.

2. Blowey, RW: Laminitis (Coriosis) - Major risk factors. Proceedings of the North American Veterinary Conference, January 1996, p. 613-614.

3. Blood, Henderson and Radostits: Veterinary Medicine. Fifth Edition, 1979.

4. Brizzi, A: Bovine digital dermatitis. The Bovine Practitioner, September, 1993, No. 27, p. 33-37.

5. Clackson, DA, and Ward, WR: Farm tracks, stockman's herding and lameness in dairy cattle. Vet Record, 1991, 129:511-512.

6. Clarkson, MJ, et al: An epidemiological study to determine the risk factors of lameness in dairy cows. (As cited by Ward), Proceedings of the International Conference on Bovine Lameness, Banff, Canada, 1994, p. 301-302.

7. Egerton JR, Yong, WK, and Riffkin, GG: Footrot and Foot Abscesses of Ruminants. CRC Press, 1989.

8. Esslemont, RJ and Peeler EJ: The scope for raising margins in dairy herds by improving fertility and health. Br. Vet. J. 1993, 149:537-547.

9. Greenough, PR: "The subclinical laminitis syndrome". The Bovine Practitioner, 1985, 20:144-149.

10. Greenough, PR: "Pododermatitis Circumscripta (Ulceration of the Sole) in Cattle". Agri-Practice, Nov-Dec 1987, p. 17-22.

11. Guard, C: Recognizing and managing infectious causes of lameness in cattle. The AABP Proceedings, January 1995, No. 27, p. 80-82.

12. Guard, C: Laminitis in dairy cattle: Recognition of the disorder and management of the causative factors. The AABP Proceedings, January 1996, No. 28, p. 71-74.

13. Leonard, F, et al: Effect of overcrowded housing conditions on foot lesion development in first-calved Friesian heifers. Proceedings of the International Conference on Bovine Lameness, Banff, Canada, 1994, p. 299-300.

14. McDaniel, BT: "Management and housing factors affecting feet and leg soundness in dairy cattle". Proceedings of the American Association of Bovine Practitioners 1983, 14:41-49.

15. Mortellaro, CM: Digital dermatitis. International conference on bovine lameness, Banff, Canada, June 26-30, 1994, p. 137-141.

16. Mortensen, K: Bovine laminitis (diffuse aseptic pododermatitis) clinical and pathological findings. Proceedings of the International Conference on Bovine Lameness, Banff, Canada, 1994, p. 210-226.

17. Nelson, DR, and Petersen, GC: "Foot Diseases in Cattle. Part I. Examination and special procedures". Compendium of Continuing Education 1984, 6;9:543-550.

18. Ossent, P, and Lischer, CJ: Theories on the pathogenesis of bovine laminitis. Proceedings of the International Conference on Bovine Lameness, Banff, Canada, 1994, p. 207-209.

19. Petersen, GC, and Nelson, DR: "Foot Diseases in Cattle. Part II. Diagnosis and treatment". Compendium of Continuing Education 1984, 6;10:565-573.

20. Raven, T: Cattle Footcare and Claw Trimming. Farming Press Ltd., 1989.

21. Rodriguez-Lainz, A, Hird, DW, Walker, RL, and Read, DH: Papillomatous digital dermatitis in 458 dairies. JAVMA, 1996, 209(8):1464-1467.

22. Shearer, JK: Footwarts (Digital Dermatitis) treatment and control strategies. Proceedings of the World Dairy Expo 1995, Madison, Wisconsin.

23. Shearer, JK: Lameness in dairy cattle: laminitis, claw disease, digital dermatitis, and foot rot. ADSA 91st Annual Meeting, JDS, Vol. 79, Suppl. 1, P235, p.189.

24. Stanek, C, et al: Does the claw trimming procedure affect milk yield and milk quality factors? Proceedings of the International Conference on bovine lameness, Banff, Canada, 1994, p. 306-317.

25. Vermunt, JJ: Predisposing causes of laminitis. Proceedings of the International Conference Bovine Lameness, Banff, Canada, 1994, p. 236-258.

26. Walker, RL: Footwarts in dairy cattle: Current understanding of a complex disease. Proceedings of the 2nd Western Large Herd Dairy Management Conference, April 6-8, 1995, p. 33-40.

27. Ward, RW: Recent studies on the epidemiology of lameness. Proceedings of the International Conference on Bovine Lameness, Banff, Canada, 1994, p.197-203.

28. Ward, RW: The role of stockmanship in foot lameness in UK dairy cattle. Proceedings of the International Conference on Bovine Lameness, Banff, Canada, 1994, p. 301-302.

29. Weaver, DA: "Digital Sepsis: Etiology and Control". The Bovine Practitioner 1988, p. 23.

30. Weaver, DA: "Laminitis". The Bovine Practitioner 1988, p. 85-87.

APPENDIX I.

TOPICAL TREATMENT FOR DIGITAL DERMATITIS

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SUGGESTED PRODUCTS:

Terramycin-343 by Pfizer (102.4 grams oxytetracycline HCl)
Terramycin Soluble Powder by Pfizer (10 grams of oxytetracycline HCl)
Lincomix soluble powder by Upjohn (16 grams of Lincomycin HCl)

MIXING INSTRUCTIONS:

Oxytetracycline HCl soluble powder

Mix 1 packet of Terramycin-343 in 1 gallon of distilled water. This makes a 25 mg/ml concentration. If using the 51.2 gram packet of Terramycin-343, add 2 packets to 1 gallon of distilled water or 1 packet in a half gallon to achieve same concentration.

Smaller herds or herds treating a smaller number of animals may use 1-2 Terramycin (10 gram packets) in a quart of water. This makes a 10-20 mg/ml concentration of oxytetracycline which is more dilute but still effective.

Lincomycin HCl soluble powder

Mix 1 packet of Lincomix in 2 liters (quarts) of distilled water. This makes an 8 mg/ml concentration of Lincomycin HCl.

DIRECTIONS FOR USE:

Use as a topical spray at the rate of 10-20 cc per foot. Apply to heels and interdigital space (cleft) or areas with visible lesions using a garden-type hand pump sprayer or other suitable spray treatment device.

SUGGESTED TREATMENT REGIME

Week 1

Treat all feet of all cows once daily for a period of 5-7 consecutive days.

Week 2 and beyond*:

Continue daily topical spray treatment of all cows with visible lesion(s) only.

*Because lesions tend to reoccur topical spray treatment must continue indefinitely! Periodic retreatment (every 3-4 months of all feet of all cows as described for Week 1 treatment is advised.

PRECAUTIONS:

This treatment represents an extra-label use of these products, dairymen are advised to consult with their veterinarian for proper labelling and further instruction.