

# Advances in Bovine Digital Diseases

**A. David Weaver, PhD, FRCVS**

*Department of Veterinary Medicine and Surgery*

*College of Veterinary Medicine*

*University of Missouri, Columbia, MO 65211*

A full week was devoted to discussion, sometimes heated, of bovine digital problems at a meeting organized by the British Cattle Veterinary Association in Liverpool, England, July 16-20, 1990. The first and last days, confined to members of the international study group on diseases of the ruminant digit (sixth meeting) involved twenty papers and considerable discussion on recent observations and studies. The three intervening days' program was a forum for an "Update in Cattle Lameness" (US \$20 or £12 sterling post free from Dr. R. D. Murray, Department of Veterinary Clinical Studies, University of Liverpool Field Station, "Leahurst", Neaton, S. Wirral, Cheshire L64 7TE, England) attended by over 200 veterinarians and others, including large, predominantly European and Japanese contingents.

Growing public pressure, as stated by Richard Murray in his foreword, demands that the veterinary profession should exercise a more critical role in the welfare of cattle kept in intensive and semi-intensive systems.

## Laminitis

A major topic was bovine laminitis. It was claimed by Graham David that more precision should be used in defining the term. The current emphasis on nutritional disturbances should not detract from investigation of behavioral, management and genetic factors. David summarized his work suggesting that laminitis developed in susceptible cattle in unfavorable housing conditions, such as the sudden introduction of heifers to concrete floors in advanced gestation, and inadequately utilized cubicle space for young cows in early lactation, as well as problems in cows found to walk over poor quality tracks to pastures.

The frequently used term "subclinical laminitis", refers to solar hemorrhages and physically softer, yellow horn in cattle which, by definition, show no clinical signs of lameness. Vemunt and Greenough found that in a Saskatchewan dairy herd solar hemorrhages were more severe four months prepartum in pregnant heifers than in cows and that the lesions in both groups tended to worsen at calving. Unexpectedly, the hemorrhages disappeared postpartum in heifers but not in second-calf and older cows.

Leaver reviewed several papers published with his former colleague Manson (see *Anim. Prod.* 1988 47 :185-190, 191-199, 1989 49 :15-22) on the effects of diet on lameness, which was graded according to a locomotion score (1 - normal, 5 - severely lame). Leaver found that in two groups of September/October calving cows, although both groups were fed the same total amount of concentrates over the winter, the group fed to yield (a greater proportion of concentrates in early lactation and to higher yields) had significantly more lameness (a higher locomotion score) than the group fed the same daily amount for 26 weeks. Lameness in another Leaver study was more prevalent in cattle on a high proportion of concentrates in the total diet than a low proportion. The same work showed high starch was more detrimental to cows, resulting in a higher locomotion score, than low starch concentrates.

In a three-year epidemiological study in progress at the University of Liverpool involving 38 dairy herds in four geographical areas of the U.K., the mean number of feet treated per 100 cows was 23.4% (herd range 2-100%) over a five-month winter housing period. There was no association between the type of concentrate feeding (to yield or flat rate feeding). Four herds which were fed a sodium bicarbonate supplement had a considerably lower incidence (5%) than unsupplemented herds (25.7%). Sole ulcers and laminitic lesions accounted for 38% of all foot lesions.

An extensive survey by Philipot and Pluvinaige in 1987 involved examination of a single hind foot, following foot trimming, of 4,896 dairy cows of different breeds. The survey was conducted by specifically trained personnel at the end of the winter-housing period. 8.2% of the cows were lame, yet over 80% of all cows showed at least one digital lesion. At least 25% of cows were affected by the 4 most frequent lesions: heelhorn erosion (55%), sole hemorrhage (49%), dorsal concavity of the wall (29%), and yellowish coloring of the sole (27%). Statistical analysis revealed a highly significant correlation ( $P < 0.0001$ ) between the following pairs of lesions: wall-rings and dorsal concavity of wall; yellowish coloring and solar hemorrhage; yellowish coloring and white line separation; hemorrhage of sole and heel horn erosion. The speakers emphasized the difference they saw between lesions, such as heel horn erosion, not necessar-

---

*This report on the BCVA Symposium on cattle lameness in Liverpool, England was not received in time for publication in the 1991 Bovine Practitioner. (The Journal was not published in 1992).*

ily causing lameness, and other indicators of serious lesions, associated with lameness, such as detachment of heel horn, sole ulcer and interdigital hyperplasia. Resulting from their study this French group defined five generic indicators, two involving heel horn erosion, the first being "benign" (2,180 cows) the second "serious" (566). One indicator of chronic laminitis (1963) and two of subclinical laminitis (benign laminitis: 698 cows; serious laminitis: 602 cows) led the investigators to pose the final question: "Do these distinct indicators of subclinical and chronic laminitis represent two different diseases or two stages of a single disease?". The international study group established a working party to promote collaborative studies on the etiopathogenesis of laminitis and its gross and microscopic manifestations.

Vermunt (Saskatoon, now in New Zealand dairy practice) summarized his microvascular and other studies on the distribution of arterioles, venules, capillaries and veins, including the presence of a diffuse anastomosing venous plexus which originated from the marginal vein. The interior half of the dermal laminae contained arteriovenous anastomoses, focal enlargements and distensions of the capillary bed. These anastomoses were seen throughout the corium, predominantly located at the base of dermal papillae and laminae. Both the anastomoses and focal enlargements may have a significant role in the pathophysiology of bovine laminitis and sole ulcer. This study of normal animals was done in eight-month-old calves. Mortensen and her co-workers (Denmark) gave preliminary data on a two-year study of fattening cattle involving 110 (year 1) and 72 (year 2) calves, the progeny of 14 sires of 3 breeds housed in 3 different ways and fed different proportions of grass silage, barley silage and concentrates. The deleterious effects of high levels of concentrate feed, seen as ruminal hypotonicity and tympany, chronic laminitis, distended joints and tendon sheaths in live animals, and in a foamy pasty rumen juice and hyperaemic, clumped and necrotic ruminal papillae and abomasal ulcers at necropsy differed markedly. Holsteins were much more susceptible than Jerseys to laminitis. Certain sires' lines were more susceptible. McDaniel pointed out that he had found the frequency of rumination to be twice as high in Jerseys as in Holsteins. Mortensen noted that black hooves were less susceptible than white to laminitic changes as melanin reduces the oxidative radicals and protects methionine, giving increased resistance to wear.

Greenough (Saskatoon), expanding on a paper about laminitis-like changes in feedlot cattle (Canad Vet J 1990; 31:202-208), referred to the tendency for laminitis to be episodic, explaining the production of horizontal linear striations in the wall horn of both the toe and heel region. The heel striation often ended in an oblique groove in the heel horn (heel horn necrosis), and he postulated a relationship between episodic laminitis

and heel horn necrosis. Commenting further on terminology, Greenough wondered whether, while acute disease might be strictly called laminitis, histopathologists would consider the subclinical condition to be laminosis. This term found no support at the meeting.

Bargai (Israel) found hyperalbuminaemia and elevated serum CPK and GGT values in 3-6 month-old calves which had clinical laminitis. Each year (1984-89) such calves had arched backs supracoronary swelling, overgrown hooves, weight loss, and tended sometimes to walk on knuckled fetlocks. Radiographs of affected calves showed rotation of P3 and dilated vascular channels. Gross necropsy features consistently included hemorrhages and congestion of the laminae. Compared with control calves (16% protein in limited concentrate diet), affected calves were fed an 18% CP ration *ad. lib.* Correction of the ration to 16% CP had eliminated the problem in the last 8 months.

### Welfare and Husbandry

Potter and Broom reminded the meeting of the five freedoms defined by the Farm Animal Welfare Council in 1983: freedom from hunger and malnutrition, thermal and physical discomfort, injury and disease, suppression of normal behavior, and fear and stress. Dr. Broom, Professor of Animal Welfare in Cambridge University, believed that lameness should not be considered only in terms of injury and disease, as it can affect each of these five freedoms. He considered that attention to building design and social factors in the herd was vital and gave several examples. In a study of a commercial Friesian dairy herd, high-ranking cows strongly preferred to feed at a particular section of the feed barrier, often at the far ends. Low-ranking cows spent a slightly shorter time in feeding. It was concluded that a long feed barrier, allowing all cows to feed simultaneously, was a desirable design. Another study showed a considerable increase of time spent by cows in chasing other individuals when the number of feed places was reduced. Similarly, low-ranked cows spent more time standing in passageways than lying in cubicles when lying space was limited. Social factors, it has been hypothesized by Eddy (1989), can contribute to the high incidence of sole ulcers in purchased heifers, which spend more time standing than older herd members.

A low cost cow mattress providing a dry resilient bed was described by Cermak. The cover of this mattress is made of a geo-textile material (Geolon 40 and 80 - Nicolon Ltd.). It is filled with straw. This mat has been tested both in Michigan (W. Bickert, MSU) and in Reading, England.

## Footcare

Footcare, in terms of paring, was extensively discussed following widespread recognition of the value of the obligatory courses run for trimmers in the Netherlands, the principles of which have been exhaustively detailed in several publications (see E. Toussaint Raven: "Cattle Footcare and Claw Trimming", Farming Press Ipswich 1984). Collick outlined the five steps to restoration of normal claw function as: 1) an appreciation of claw balance with equal weight sharing; 2) the bearing surfaces should be flat to maximize ground contact; 3) length of lateral (rear) claw should be reduced to that of (more normal) medial claw; 4) according minimal trimming should be done on medial claw; and 5) special attention should be paid to production of a similar heel height, so that leg axis is vertical.

In a study of eleven dairy herds in Somerset, England, enrolled in a herd health program, only a quarter of nearly 2,000 feet which were examined were considered normal, the most frequent abnormality being unequal claw size. Common foot lesions included sole ulcer and white line lesions. Interdigital phlegmon ("foul") and digital dermatitis were rarely seen.

Collick has used the locomotion score (grades 1-5, increasing scores indicating poorer locomotion and lameness being evident at a score of 3) devised by Manson and Leaver (1988). On his study farms, Collick found the mean score for all cows was 2.22 before and 1.87 after trimming. More impressive was the percentage of cows which had a score of 3 or above before (24%) and after trimming (6%). Collick emphasized the usefulness of this scoring system in creating an awareness of the lameness problem in the mind of stock-persons.

## Laboratory Studies

The role of endotoxin in the production of lesions of the ruminant digit was reported by Andersen (Copenhagen). The study was stimulated by widespread belief in the hypothesis that rumen acidosis is associated with a dramatic increase in ruminal endotoxin concentration. Only the experimental administration of rumen bacterial endotoxin appears to elicit all the typical signs of acute rumen acidosis. Using the only available endotoxin analysis method which is sensitive enough to measure the very low concentrations of endotoxin in blood (*Limulus amoebocyte lysate*), but which cannot differentiate the ever-present contaminants, Andersen first confirmed that rumen endotoxin concentrations were much higher in steers after a change from hay onto a grain ration. These changes started 3 days following the sudden addition of a grain supplement. When cows were fed concentrates *ad lib*, endotoxin concentrations increased up to eightfold. Although a severe rumen acido-

sis developed, the rumen endotoxin concentrations were unchanged or even fell in cows which had been fed hay and then given 70 g barley per kg bw through a rumen fistula. Compared with dramatic increases in concentration in steers which were offered both hay and grain *ad lib* and which then received the same grain inoculation, it appears that the process of adaptation of the rumen environment of grain feeding leads to a greater production or release of free endotoxin in rumen fluid.

Andersen has previously demonstrated portal vein endotoxemia in healthy ruminants and also in experimentally-induced rumen acidosis. Endotoxins in blood were not found in his later experiments in concentrations above the detection limit of 0.03 Eu/ml plasma. A lower concentration would be of no clinical significance. Plasma endotoxin clearance by the liver is a very fast, but portal endotoxemia may cause the development of clinical signs of rumen acidosis through the synthesis of inflammatory mediators in the ruminal wall, prehepatic endothelial cells and thrombocytes, or in hepatic tissue.

## Digital Dermatitis

Blowey described digital dermatitis as seen in his Gloucestershire practice. A similar problem has been reported in USA, northern Italy, and the Netherlands in the last 10-15 years and the incidence appears to be increasing. Newly introduced down-calving heifers seem to be particularly prone to the disease. The lesion is often very sensitive to touch and causes discomfort in some cows and obvious lameness in others. It primarily affects the skin of the plantar region proximal to the heel bulbs. A thick brownish exudate covers a moist granulomatous area, through which matted hairs protrude. Severe cases are associated with heel erosion. These changes affect rear feet more severely, though in some cows all four feet are involved. Sometimes lesions are evident at the dorsal part of the interdigital space or, rarely, on the abaxial or axial coronary band. Proliferative lesions, reported from the USA and Italy, were not seen in his practice area. Histopathological changes in the UK and Irish studies included superficial suppurative changes in a thickened epidermis.

Differential diagnoses include interdigital phlegmon (necrobacillosis) and interdigital dermatitis, both of which rarely involve the digital skin. The etiology of digital dermatitis is still uncertain. An infectious agent seems likely in view of the rapid spread within some herds, and the rapid response of most cases to topical antibiotics and gentian violet. *Bacteroides* species have been isolated from typical cases. Blowey found that his herds failed to respond to formalin footbaths but that satisfactory control was achieved with baths containing either 2-4 g/L tetracycline or 0.5 - 1 g/L dimetridazole. Various workers are continuing investigation of this newly emerging problem (see below).

The ulcerative form of digital dermatitis poses a serious problem in dairies around Iran, according to Nowrouzian. The condition, first seen in 1979, has affected nearly half the country's dairies, with prevalence rates ranging from 12-27.5% of the dairy herd. Cases were successfully treated by scrubbing the lesions with povidone iodine, cleansing, drying and topical application of oxytetracycline spray with gentian violet. Similar extensive occurrence of digital dermatitis was also reported from Czechoslovakia by Kyllar, who found formalin footbathing most effective in reducing the problem in high incidence, loose-housed dairy herds.

### Interdigital Dermatitis

Scanlan (Texas A & M) reviewed bovine contagious interdigital dermatitis (BCID) which is claimed to be similar to bovine contagious footrot (OCFR) in terms of etiological agent (synergistic relationship between *Bacteroides nodosus* and *Fusobacterium necrophorum*) and transmission. However, while BCID lesions are frequently confined to the interdigital skin, OCFR is characterized by undermining of the heel and sole horn with a secondary necrotic laminitis. The contrasting lesions and severity of BCID and OCFR have been partially attributed to differences in piliation and production of proteolytic enzymes. In BCID the earliest change is an interdigital inflammation, quickly followed by production of a grayish exudate with a possible swelling of the heel bulb but no lameness. In chronic BCID cases infection spreads onto the heel bulbs, producing pits and later linear grooves some of which, especially in hind feet, can lead to lameness.

### Epidemiology and Genetics

Wells (Minnesota) in a epidemiologic study of 17 Minnesota and Wisconsin dairy herds involving two (veterinary) observers, and using a modified Manson-Leaver lameness scale, found an overall prevalence of clinical lameness of 13.6% (summer) and 16.7% (winter), while herdsmen found a lower prevalence (respectively 6.4% and 5.6%), a trend which has been noted in other studies.

A Japanese study by Yoshitani and colleagues (Awa Prefecture) revealed major lameness problems to be sole ulcer, white line lesions and phlegmona interdigitalis. As found elsewhere, the lateral hind claw was a predilection site (87.7% of all lesions). The hot humid summers are believed to contribute to the higher incidence of lameness cases in July through October.

In a Missouri Holstein and Guernsey dairy herd, weekly lameness visits over a 5-year period (Jan. 1, 1985 to Dec. 31, 1989) revealed an annual lameness incidence of 35-56% in lactating cows, with 83% of the cases

localized to the digits. The most frequent lesions causing lameness were heel erosion (exosio unguulae) and localized septic solar laminitis. In 366 successive lameness cases the duration of lameness was 31 days for 303 digital cases and 22 days for 63 non-digital cases. Footpairing, performed twice a year was required on 86% of all cows in year 1, compared with 45% in year 5. Lesions liable to result in lameness subsequently were found in 25% of cows in year 1 and 10% in year 5. Culling for lameness or bad limb and digit conformation accounted for 17% of all culls in year 1 and 12% in year 5.

Confirming work by McDaniel in North Carolina, Baumgartner and Distl recorded genetic and phenotypic relationships of claw parameters in German Simmental cattle. They found that progeny groups with a steeper dorsal wall angle, shorter diagonal distance, and a shorter dorsal border in their first lactation had high survival rates to 60 months than progeny groups with shallow (small) angles and longer diagonal and dorsal border values. The authors believe that selection based on claw measurements may usefully increase longevity and reduce the frequency of claw diseases.

In a complementary paper McDaniel (North Carolina) claimed that selection for an increased dorsal wall angle and reduced claw length would reduce the incidence of sole ulcer, increase fertility by reducing days open, and increase milk yield from first to subsequent lactations, as well as leading to higher survival rates. McDaniel clarified that the dorsal wall angle was based on the most proximal 3 cm of hoof wall in order to overcome the problem of concavity. Inheritance of the diagonal value (abaxial coronary band to point of toe), length and dorsal angle were respectively 0.35, 0.14, and 0.19, all figures which are higher than the value for the inheritability of milk yield.

### Digital Health Program

The writer made an appeal for the introduction of an integrated digital health program to parallel similar fertility and mastitis schemes. The program would have four components: objectives, implementation, interpretation, and control. The objectives should be target figures for digital lameness incidence and prevalence, antibiotic usage for lameness and the figures of cows requiring therapeutic foot-trimming. The implementation rests entirely on accurate record keeping of regular twice daily observation of the herd. The data should include: cow number, date of commencing lameness, leg or digit, limb identification, diagnosis if possible, treatment, date no longer lame, and other remarks (e.g. reason for culling). Interpretation, such as observation of a high lameness incidence in first calf heifers, permits rational decisions for effective prophylaxis to be made. The interpretation is then translated into advice for the

farmer and stock personnel, enabling the herd to approach the target objectives. As veterinarians we are often poor at getting together in the area of digital lameness compared, for example, with targets for calving interval. We know too little about the interpretation of complete results and implementation of control measures such as the introduction and regular use of a prophylactic formalin footbath.

### **Cowtrainers**

Cowtrainers are electric low-voltage wires suspended horizontally about 5 cm over the highest point of the back in dairy cows maintained in individual tie stalls. Such cowtrainers were found by Bergsten (Sweden) in a comparative study to improve both individual cow cleanliness and also hoof health by reducing the incidence of heel horn erosions. But cowtrainers, he warned, will become illegal in Sweden in 1994.

### **Surgery**

The solitary surgical contribution to digital disease (Menzel, Germany) was an improved cryosurgical method of removing interdigital fibromata by insertion

of a hypodermic cryospray needle horizontally through the mass, which is then frozen twice by liquid nitrogen. The entire mass can be frozen within 5 minutes without a re-insertion of the needle. An Esmarch tourniquet is applied to the limb proximal to the digit to occlude the arterial blood supply and so improve the efficacy of the cryotherapy (fast, freeze, slow thaw). Anesthesia is by topical spraying with liquid nitrogen.

This summary indicates the attempts currently being made to understand the basic mechanisms involved in several digital diseases, notably laminitis and digital dermatitis. Multi-centre epidemiologic studies appear to be increasingly important. The next meeting of the international study group whose July 1991 papers are published in the BCVA Proceedings 1990-91 (available from R. D. Murray), will be held in Rebild, Jutland, Denmark, June 22-25, 1992.

---

FOR YOUR LIBRARY

## **Veterinary Diagnostic Virology: A Practitioner's Guide**

**Edited by Anthony E. Castro and Dr. Werner P. Heuschele**

This guide covers the major viral diseases of domestic animals, avians, wildlife and exotic pets in a format that is easy and enjoyable to read. Particularly important to the practitioner and diagnostician is the information on laboratory diagnosis, interpretation, prevention, control and management of each viral disease. The information on selection and submission of diagnostic specimens provides important information to the practitioner on how to best utilize diagnostic laboratory services. The chapters are very concise and provide the needed information in an easy to read style.

The book has an impressive list of contributors and appears to be very up-to-date with information on nucleic acid probes and polymerase chain reaction. This book is highly recommended for the practitioner library and answers many questions frequently asked of virologists in diagnostic laboratories. Available from Mosby Year Book Inc., 11830 Westline Industrial Drive, St. Louis, Missouri 63146.

*Reviewed by: Dr. William C. Edwards, Director and Toxicologist  
Oklahoma Animal Disease and Diagnostic Laboratory, Stillwater, OK*