DIGITAL DERMATITIS: CURRENT CONCEPTS AND RECENT RESEARCH

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Foot problems constitute the single most important ailment of captive elephants.
**Digital Dermatitis**

- **Significance**
  - Most common infectious disease affecting housed dairy cattle worldwide
  - Affects the majority of herds (70-100%)
  - Some estimates are that it affects nearly 20% of all dairy cows
- **NAHMS Survey data**
  - DD accounted for 61.8% of lameness in bred heifers and 49.1% in cows
- **Estimates of herd-level prevalence**
  - 1.4% in 34 Norwegian herds to 39% in 5 Danish herds
  - Estimates for DD in free-stall barns – 20-25%
- **A growing problem in feedlot cattle**

**DD in Dairy Cattle**

**Economic Impact**

Cost = $95-$133 per clinical case (lost production, treatment cost, and discarded milk)

$190 million per year in lost revenue in US

**Digital Dermatitis**

- **Also known as:**
  - “Mortellaro’s Disease”

Drs. Cheli and Mortellaro 1st described the disease in Italy in 1974.

**First report of digital dermatitis in the US was in beef bulls**

WH Lindley, Vicksburg Animal Clinic, Vicksburg, MS


Case report of an Angus bull affected with papillomas on the foot
A second report near the same time by,


- Study involved a polled Hereford cattle herd near Seattle, WA

Early Reports in Dairy Herds

- Report of 2 herds with painful interdigital papillomas as a herd problem
  - Herd 1
    - 130 cows in free stall housing
    - Problem reported to have begun in 1976
    - 52/130 cattle affected on hind feet
    - Affected cattle had pronounced lameness, increased lying times, lost weight and decreased milk yield (20%–50%)
      - Lesions on the palmar and plantar interdigital cleft extending into the interdigital space with papillomatous outgrowths
  - Herd 2
    - 106 free-stall housed cow herd
    - 70% of cows affected
    - Lesions same as those described in Herd 1
    - No viral agents were isolated from lesions or observed by electron microscopy

Treatment of DD in Early Reports

- Treatments applied in the New York herd reports
  - Herd 1
    - Caustic or antiseptic foot dressings applied to no effect
    - Sodium iodide and penicillin systemically
    - Surgical correction reported best treatment with follow up treatment with topical copper sulfate and sulfanilamide powder (1:4) dressing with ichthammol 20% heel pack

Typical Digital Dermatitis Lesions

Chronic Lesions of Digital Dermatitis

Courtesy of Dr. Ondrej Becvar, DVM
Digital Dermatitis: An Emerging Problem in Feedlot Cattle

Atypical Digital Dermatitis

Day 19

Follow up biopsies
- 2 Cases (Day 39)
- Hyperkeratotic, acanthotic epithelium
- Spirochetes negative

NON-HEALING TOE LESIONS IN CATTLE

Dr. Loris De Vecchi, Italy
“Udder Sores”

Also known as:
- Bovine ulcerative mammary dermatitis
- Mammary necrotic dermatitis
- Udder scald
- Udder rot

Prevalence is reportedly higher in herds with cows digital dermatitis.

Recent study of Digital Dermatitis
- Found that 2 of 3 Treponema groups were common in all samples.
- All 3 Treponema groups found in 74.5% of udder tissue samples.

Evans NJ, et al., 2010.

Cause(s) and predisposing factors?

True cause/etiology is unknown

Diagnostic work typically demonstrates bacterial spirochetes (Treponema spp.) in lesion sections.

Digital Dermatitis: Predisposing Factors

- Purchasing or raising replacements off-site
- Large herd size
- Muddy corrals (wet manure covered feet)
- Use of a hoof trimmer that trims feet on other dairies
- Washing hoof care equipment between farms
- Failure to disinfect hoof care equipment between farms
- Grooved Concrete
- Use of a footbath
- Herds with more Holsteins
- Overgrown claws

Digital Dermatitis: Treatment and Control Strategies

- Optimal control requires some combination of the following:
  - Topical Spray Treatment
  - Use of a well-managed footbath – copper sulfate, formalin or zinc sulfate
  - Topical Treatment with or without a bandage
  - Emphasis on manure management

Treatment and Control Strategies
Topical Spray Treatment of Digital Dermatitis

History of Therapy of DD

- Treatments
  - Topical therapy with tetracycline or lincomycin
    - Most trials monitored cows for less than 30 days
      - Clinical experience suggests that treatment success requires long-term follow up of individual animals to observe for lesion regression or recrudescence
    - Berry et al., followed 341 cattle for 341 days following topical Lincomycin therapy
      - 54% required retreatment before the end of the study
    - Read and Walker
      - Found that 48% lesions required retreatment within 12 weeks

Topical Treatment of Individual Cases of Digital Dermatitis

Oxytetracycline HCL
**Treatment of Digital Dermatitis**

**Bandage Versus No Bandage?**

- Canadian study by Higginson, et al.
  - **Treatment versus no treatment**
    - Cows receiving treatment were more likely to recover
  - **Bandage versus No Bandage** (i.e. topical tetracycline paste only)
    - No difference between treatments

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**Tetracycline Residues in DD Treated Cows**

- **Tetracycline residues**
  - Tolerance level is 300 ppb in US, 100 ppb in Canada
  - Cramer study
    - Cows treated with either 2, 5 or 25 grams topically per foot
    - 213 milk samples tested
      - 21 with detectable residues – highest was 63 ppb, and most within 8-27 hours post-treatment
      - Cows treated with 25 grams – all had detectable residue (below the legal limit)

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**Topical Treatment of DD and Residue**

- Cows assigned to 2 groups:
  - **Treatment 1 (n=16)**
    - topical spraying with 15 ml of 100 mg of oxytetracycline/ml
    - Lesions sprayed 2X/day for 7 days
  - **Treatment 2 (n=12)**
    - 1 time application of a bandage consisting of cotton soaked with 20 ml of 100 mg oxytetracycline/ml
    - None of the cows in either group had violative residues

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**Topical Spray Treatment**
## SPRAYING – ALTERNATIVE TO FOOTBATHS FOR CONTROLLING DIGITAL DERMATITIS

<table>
<thead>
<tr>
<th>Drug or compound</th>
<th>Tetracycline or Oxytetracycline (soluble powder formulations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration</td>
<td>Rates vary from 10 - 25 grams/liter</td>
</tr>
<tr>
<td>Application</td>
<td>Use as a topical spray at the rate of 10 to 20 cc per foot. Apply to visible lesions.</td>
</tr>
</tbody>
</table>

### Treatment Regimen
- **Wk 1:** Treat all feet of all cows once daily for 5 to 7 consecutive days;
- **Wk 2 and beyond:** Continue daily topical treatment of all cows with visible lesions only.

*Note: An extra label use for these products. Consult your local veterinarian for proper labeling and treatment instructions.*

### Topical Spray Treatment

<table>
<thead>
<tr>
<th>Lesion and foot posture prior to treatment</th>
<th>Lesion and foot posture 3 days post-topical spray treatment.</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Severe lameness" /></td>
<td><img src="image2" alt="No detectable lameness" /></td>
</tr>
<tr>
<td><img src="image3" alt="Severe lameness" /></td>
<td><img src="image4" alt="Severe lameness" /></td>
</tr>
<tr>
<td><img src="image5" alt="No detectable lameness" /></td>
<td><img src="image6" alt="No detectable lameness" /></td>
</tr>
</tbody>
</table>

*Severe lameness and foot 2 weeks following topical spray treatment with Oxytetracycline 25 mg/liter.*
Footbaths

Design and Compounds Used

“Stand-in” Footbath

Footbath Design

- Footbath dimensions to maximize foot immersions:
  - Length
    - 10-12 ft. (3.0-3.7 m)
  - Width
    - 18-24 inches (.5-.6 m)
  - Step-in Height
    - 10-11 inches (28 centimeters)
- The higher step-in design improves retention of footbath solutions

Disinfectants Commonly Used

Formalin, Copper Sulfate (with or without acidifiers)

Formaldehyde/Formalin (Formol)

- Formaldehyde
  - a colorless gas at normal conditions
- Formalin - a saturated water solution
  - Contains about 40% formaldehyde by volume or 37% by mass, is called "100% formalin"
    - Most contains a small amount of stabilizer such as methanol
      - Methanol (10-12%) suppresses oxidation and polymerization to paraformaldehyde
    - A concentration of 3-5% may be used without causing skin irritation
Formalin Concentrations Above 5%

- Disadvantages of Formaldehyde footbaths
  - Human Exposure risks
  - Suspected carcinogen
  - Below 45° to 50° F (4.4-10° C) - effectiveness questionable
    - Polymerizes into inactive paraformaldehyde when stored at ≤ 60° F (15.5° C)
    - Addition of methanol helps prevent this
  - Can cause foot skin damage if improperly mixed

Copper Sulfate

- 5-10% copper sulfate
  - Antibacterial, drying agent
  - Less effective than formalin
  - More expensive
  - Phytotoxicity - a major drawback with long term use

Research on Digital Dermatitis

- 61 Adult Holstein Cows - ISU Dairy Farm
  - Assigned to random pens within herd
  - RFID collars diverted cows away from herd footbath
  - Cows lifted on tilt table every 3-4 weeks
  - Biopsy lesions throughout development
  - Monitor and treat lameness

Publications


Study Statistics

- 32 months of natural lesion development
- 900+ tilt-table examinations of trial cows
- 10,000+ digital photographs taken
- 1000+ biopsies taken
- 350+ blood samples collected

Observations

- “Classic” lesions were always preceded by distinct morphological changes

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[Diagram showing lesion progression]
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“Classic” Lesions

Type 3 Lesion
Type 4 Lesion

Pre-Lesion

Type 3 Lesions
Type 4 Lesions

Treatment

Regression

Lesions
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Lesion Progression Example

Day: 0

[Image of lesion on Day 0]

Day: 25

[Image of lesion on Day 25]
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Lesion Progression Example

Day: 35

Lesion Progression Example

Day: 60

Lesion Progression Example

Day: 88

Lesion Progression Example

Day: 164

Observations

• All lesions monitored for > 4 months after reaching highest pre-lesion stage
• Average time to develop to stage 3 lesion:
  • 147 days, Range 37 – 522 days
• Severe Lameness (L3-4) not always associated with onset of lesion development and only occurred in stage 3/4
• Range 0 – 330 days post onset

Chronic severe DD lesions
• Following 1X topical treatment with tetracycline powder
  – Only 6/44 (14%) of lesions returned to normal skin and did not reoccur

How effective is treatment?

Krafft et al., 2014
Metagenomic development of bovine digital dermatitis in US dairy cattle.

- At present it is estimated that we can only grow less than 10% of the bacteria that exist
- Culture and PCR based methods require a priori knowledge of what you want to look for
- Metagenomics sequences all of the DNA from a sample and identifies the microbial component based on the DNA presence without prior knowledge of what might be there and allows for direct comparisons of abundance of organisms between samples.

Kruell et al. Infection and Immunity 2014

Lesion Spirochetes

Presence of Spirochetes within pre-lesions did not increase risk of developing to stage 3 or 4 lesion.

Bacterial Profile by Stage

Practical Uses of Metagenomics

- Using metagenomics to predict lesion progression or healing
  - Preliminary studies
    - 80% accuracy at predicting the likelihood of lesion healing at 3 months post treatment based on bacterial profile at 10 days post treatment
- These techniques may also be used to evaluate treatment efficacy in vivo

Kruell et al. Infection and Immunity 2014

Summary Observations

- Average time to develop to stage 3 lesion: – 147 days, Range 37 – 522 days
- Lameness not always associated with onset of advanced (stage 3) lesion development
  - Range 0 – 330 days post onset
  - Thus, locomotion scoring is not an effective way to detect DD
- Spirochetes are most abundant in mature lesions
- Single point treatment has high level of recrudescence

Lesion Induction Studies
Lesion Induction Research

“Be who you are and say what you feel, because those who mind don’t matter and those who matter don’t mind.”

Dr. Seuss