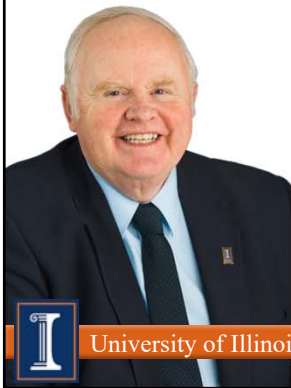


Feeding Considerations Impacting Lameness and Hoof Health



**Penn State Workshop
November 15, 2017**

**Mike Hutjens, Professor of
Animal Sciences Emeritus**



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Today's Workshop

- An overview of feeding relationships to lameness and hoof health
- Results of a new Wisconsin field study on digital dermatitis (DD)



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Fact 1: Prevalence of Lameness

Selected rates reported research:

Farm average = 21 to 55%

Range for individual farms ~3 to 80%



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Fact 2: Farmer Perception of Lameness

2.5 to 4 times

Lower lameness prevalence
than estimated by researchers



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Fact 3:
**An Important
Animal Welfare
Issue**



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Consequences of Lameness

- Animal welfare
- Locomotion and posture
- Foot shape
- Culling rate
- Reduced milk production
- Decreased reproductive performance



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Effect of Lameness on Cull Rates

Culling rates for lame and non-lame cows before the start of breeding events at 95 days

5.4% for non-lame cows vs. 30.8% for lame cows (approximately 6 times the control group)



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Melendez *et al.*, 2003, Theriogenology 59:927-937

Effects of Lameness on Reproductive Performance

Cows developing lameness within 30 days post-calving were **2.6 times** as likely to develop cystic ovarian disease before breeding compared with normal COWS.



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Melendez *et al.* 2002, Theriogenology 59:927-937.

Evaluating Lameness at the Farm Level



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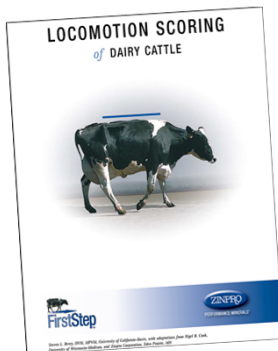
Locomotion Scoring

Score	Description	Back	Assessment
1	Normal	Flat	Cow stands and walks with a level back. Gait is normal.
2	Mildly lame	Flat or Arched	Cow stands with level back, but back is arched when walking. Gait is normal.
3	Moderately Lame	Arched	Cow stands and walks with an arched back. Gait is short-strided.
4	Lame	Arched	Arched back is always evident, and gait is one deliberate step at a time. Cow favors one or more legs/feet.
5	Severely Lame	3-legged	Cow is unable or very reluctant to bear weight on one or more limbs/feet.



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Adapted from Sprecher et.al. (Theriogenology 47:1179-1187;1997)



Locomotion Scoring

Courtesy of



PERFORMANCE MINERALS™

Locomotion Score

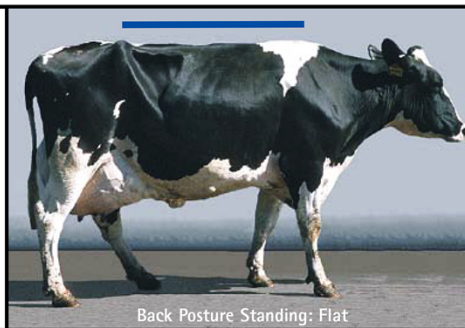
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Clinical Description:

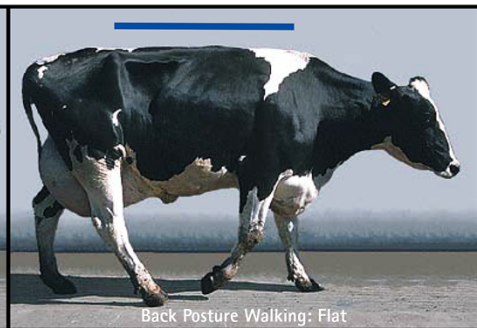
Normal

Description:

Stands and walks normally with a level back. Makes long confident strides.



Back Posture Standing: Flat



Back Posture Walking: Flat

Locomotion Score

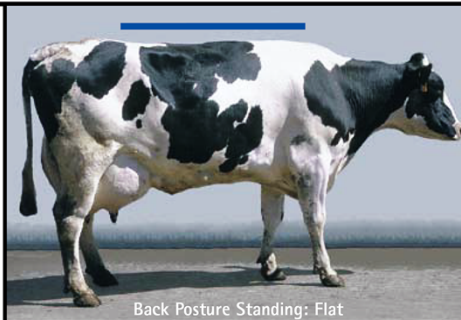
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Clinical Description:

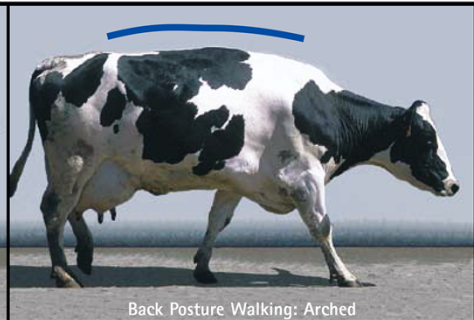
Mildly Lamé

Description:

Stands with flat back, but arches when walks. Gait is slightly abnormal.



Back Posture Standing: Flat



Back Posture Walking: Arched

Locomotion Score

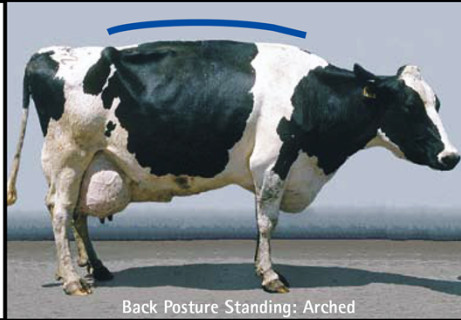
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Clinical Description:

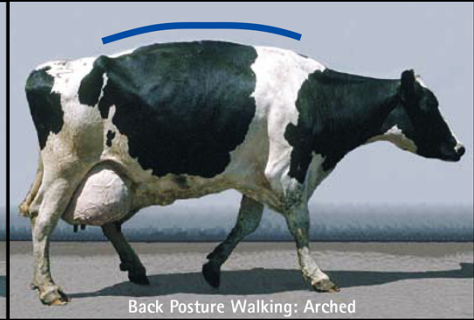
Moderately Lamé

Description:

Stands and walks with an arched back and short strides with one or more legs. Slight sinking of dew-claws in limb opposite to the affected limb may be evident.



Back Posture Standing: Arched



Back Posture Walking: Arched

Locomotion Score

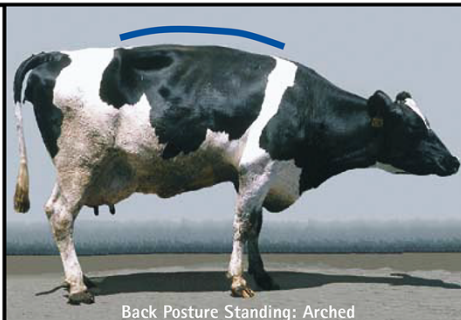
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Clinical Description:

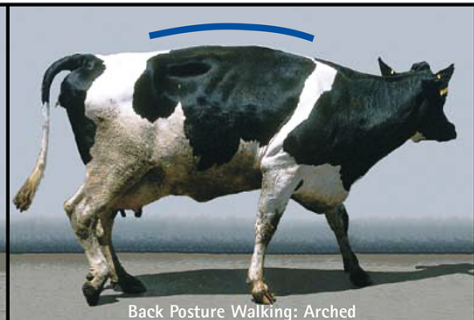
Lamé

Description:

Arched back standing and walking. Favoring one or more limbs but can still bear some weight on them. Sinking of the dew-claws is evident in the limb opposite to the affected limb.



Back Posture Standing: Arched



Back Posture Walking: Arched

Locomotion Score

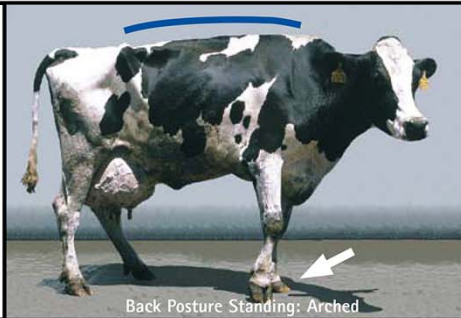
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Clinical Description:

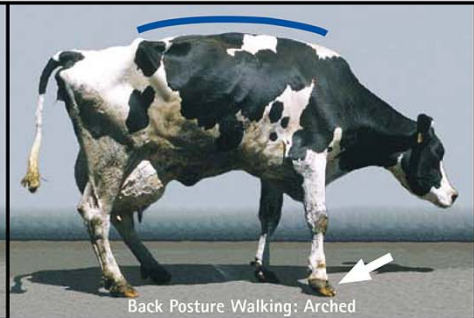
Severely Lamé

Description:

Pronounced arching of back. Reluctant to move, with almost complete weight transfer off the affected limb.



Back Posture Standing: Arched



Back Posture Walking: Arched

* Adapted from Sprecher, D.J.; Hostettler, D.E.; Kaneene, J.B. 1997. Theriogenology 47:1178-1187 and contribution from Cook, N.B., University of Wisconsin.

Cost of Lameness

	Amount Lost	Value
Death	2% - replacement cost \$2200	\$44
Culling	12% replacement/cull \$2200 - \$600	\$192
Milk Loss	940 lb milk at \$0.09/lb	\$170
Reproduction	20 extra days at \$3.00/day	\$60
Treatment	.05 hr. labor + trimmer fee + supplies	\$32
		Total \$498



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Adapted from CL Guard, 2008 Bovine Lameness Seminar & 2006 AABP Proceedings 2006.

Impact of Lameness Scores (California)

Score	Percent	Milk Drop	DMI drop
Score 1	75	none	none
Score 2	15	none	1 %
Score 3	9	5 %	3 %
Score 4	< 0.5	17 %	7 %
Score 5	< 0.5	36 %	16 %



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Significance of Locomotion Scores

Cows with a locomotion score 3

2.8 times more likely to have increased days to 1st service

15.6 times more likely to have increased days open

9.0 times more likely to have more services per conception

8.4 times more likely to be culled than herd mates



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Sprecher, *et al.*, Theriogenology, 1997, 47:1179-1187.

Understanding Laminitis



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Laminitis

- Inflammation of the vascular hoof tissues
 - laminae = vascular hoof tissues
 - itis = inflammation
- Sensitive laminae
 - associated with the bone
- Insensitive laminae
 - associated with the hoof wall



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Laminitis Relationships

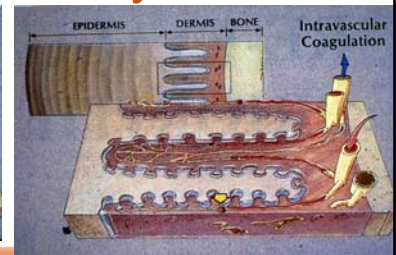
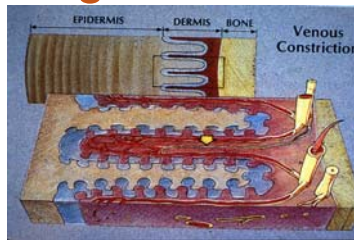
- Sensitive laminae die without oxygen from reduced of blood flow
- Corium becomes inflamed
- Inflammation and edema increase pressure inside hoof wall causing pain
- Painful animals walk less
 - Natural pumping action reduced
 - Blood flow stagnates inside hooves
 - Further damage to sensitive laminae occurs



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Pathogenesis of Laminitis

- Vascular damage during laminitis caused by:
 - Venous constriction
 - Intravascular coagulation
- Vascular events thought to be mediated by:
 - Endotoxins
 - Histamine
 - Lactate



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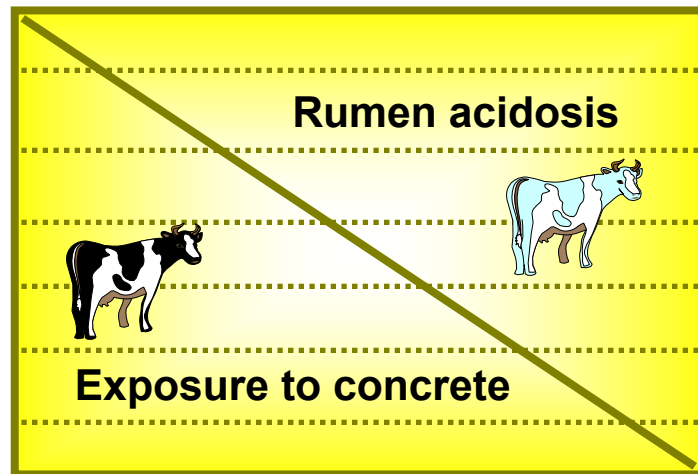
Factors That Might Weaken the Suspensory Apparatus

1. Enzymes (metalloproteinases) breakdown or weaken the collagen fibers in the corium
2. Weakness may be brought about by hormonal changes at or around calving (such as relaxin)
3. Factors causing structural alteration of the collagen fiber bundles



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Degree of Interaction



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Feeding Factors



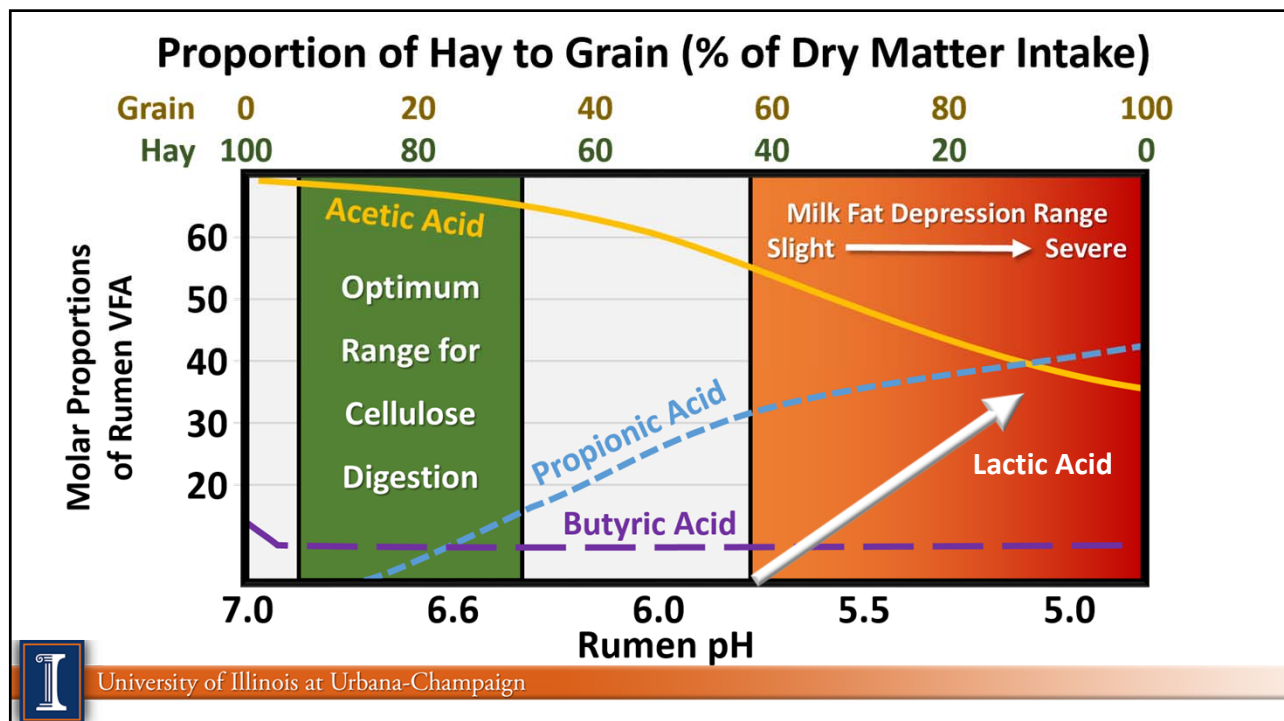
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Excess Rapidly Fermentable Carbohydrates

- VFA exceeds rumen wall absorption
- Reduces rumen pH - below 5.5
- Lactic acid bacteria proliferate
- Vasoactive substances released in blood
- Damage to vessels in sensitive laminae



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Signs of Acidosis

- Free choice bicarb consumption (< 45 g or 0.1 per cow per day)
- Erratic shifts in dry matter intake (> 2 lb or 1 kg per cow per day)
- Laminitis (> 10% lameness score 3)
- Loose fecal droppings (manure score < 2.5)
- Consumption of bedding and dirt



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Transition Phase Risks for Laminitis

- Rumen microbial populations
 - pH affects types of microbes
 - ✓ starch digesters vs fiber digesters
 - May take 10-14 days to stabilize
- Rumen papillae
 - Surface area for VFA absorption
 - Require 6-8 weeks to develop
 - Every acidotic episode sets them back



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Starch and Sugar Considerations

- Starch levels (22 to 30%)
- Rumen starch availability (55 to 85%)
- Starch sources (wheat>barley>corn)
- Sugar levels (5 to 7%)



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Fiber Carbohydrate Guidelines

Total aNDFom 28 to 33%

uNDF-30 (forages) 12 to 14%

Effective NDF 19 to 22%

ADF 19 to 21%

Lignin 3 to 4%



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Physically effective fiber

- Minimum of 450 minutes of cud chewing using rumen monitoring devices (550 to 600 minutes)
- 5lb (2kg) of feed particles over $\frac{3}{4}$ inch (18 mm)
- > 50% of total dry matter in top two boxes of the Penn State Box (> 8% top; >40% 2nd box)



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Penn State Separator / IL) (3rd boxes)

	Top	Middle	Bottom
	-----% (as fed)-----		
TMR	2-8	> 40	<50
Haylage	> 20	> 60	< 25
Corn silage	5-15	> 50	<35



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Penn State Separator Guidelines

(IL—3rd box @ 1.1 mm)

	Top -----	2 nd % (as fed)	3 rd	Bottom -----
TMR	2- 8	> 40	< 30	< 20
Haylage	> 20	> 40	< 20	< 5
Corn silage (3/4 TLC-Process)	5-15	> 50	< 30	< 5



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Penn State Separator / PA (3rd box at 4.0 mm)

	Top -----	2 nd	3 rd	Bottom -----
	% (as fed)			
TMR	2-8	30-50	30-50	< 20
Haylage	10-20	40-75	20-30	< 5
Corn silage	3-8	10-20	30-40	< 5



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Reducing Feed Sorting

- Reduce forage particle size < 2 inches
- Increase forage quality
- Reduce the amount of hay
- Add 5 to 7 pounds of water and evaluate
- Considering adding liquid molasses, corn distillers solubles, or other wet ingredient
- Feed more frequently each day



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Protein Quality and Quantity

- Higher levels of RDP (< 11% RDP) or total quantity of protein (<16.5%%) may produce rumen fermentation that impacts hoof hardness
- Sulfur containing amino acids can impact hoof health (0.25 to 0.28% of DM)



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PUFA (polyunsaturated fatty acids)

- Reduce fiber digestion in the rumen and shift rumen microbial population
- Shift rumen VFA pattern (less acetate)
- < 500 grams of total ration PUFA/cow/day
- < 225 grams of vegetable oil in the free form and/or under 50 grams of fish oil



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Copper Aspects

- Synthesis and maintain elastic tissue (tendons)
- Produce thiol oxidase increasing hoof hardness via disulfate keratin bonds
- Immunity role as superoxide dismutase
- 10 to 15 ppm (1/4 from organic sources)



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Zinc Considerations

- Component of 300 enzyme systems
- Improve wound healing, keratin synthesis, and epithelium maintenance
- Improve hoof hardness and hoof health
- 40 to 60 ppm
(1/4 to 1/3 from organic sources)



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Organic Zinc and Hoof Health

Hoof health (3,000 cows study)

- 34% reduction white line ($P < 0.001$)
- 11% reduction sole ulcers ($P < 0.05$)
- 33% reduction in digital dermatitis ($P < 0.01$)



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Additional Mineral Considerations

- Manganese: Bone density and joint structure with oxidative damage control (40 to 60 ppm)
- Sulfur: amino acids synthesis and vitamins (biotin and thiamine) (0.25 to 0.28%)
- Calcium and phosphorous: Bone formation and skeletal soundness



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Biotin

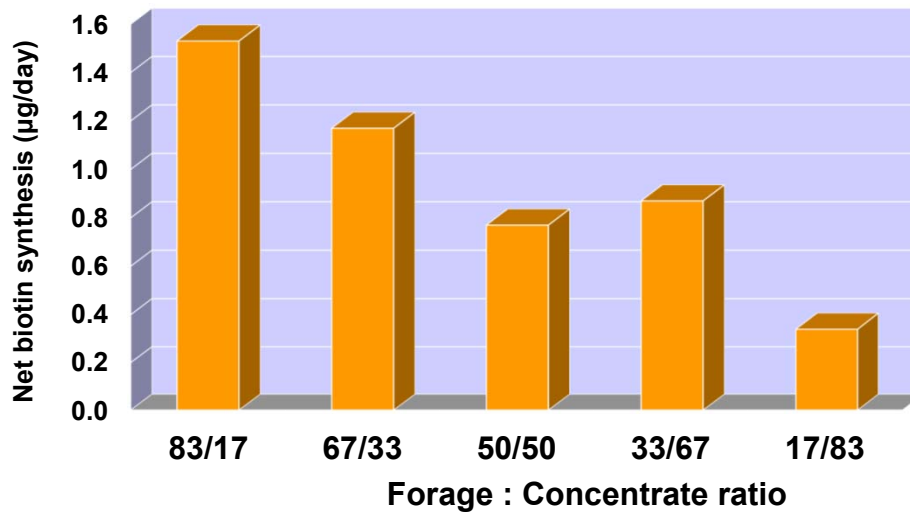
Improve hooves by reducing heel warts, claw lesions, white line separations, sand cracks, and sole ulcers; increase milk yield

- **Level:** 10 to 20 mg/cow/day for 6 mo to 1 year
- **Cost:** 4 to 10 cents/cow/day
- **Benefit to Cost Ratio:** 4:1



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Synthesis of Biotin - an *in vitro* study



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Da Costa Gomez et al., 1998

Influence of biotin on foot lesions

Clinical summary

Lesion	Reference	Biotin dose	Response
Sole ulcer	Hagemeister, (1996)	10 mg	Significant reduction in sole ulcers and heel erosion
	Lischer et al, (1996) Koller et al, (1998)	20 mg	New horn formed more rapidly Structure of new horn was improved
Digital dermatitis	Distl & Schmid, (1994)	20mg	20-37% lower incidence of "heel warts" in an 11 month study
Vertical fissures	Campbell et al, (1996)	10mg (Beef cows)	Incidence of sandcracks: Control 29.4% Treatment 14.3%



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Influence of biotin on foot lesions

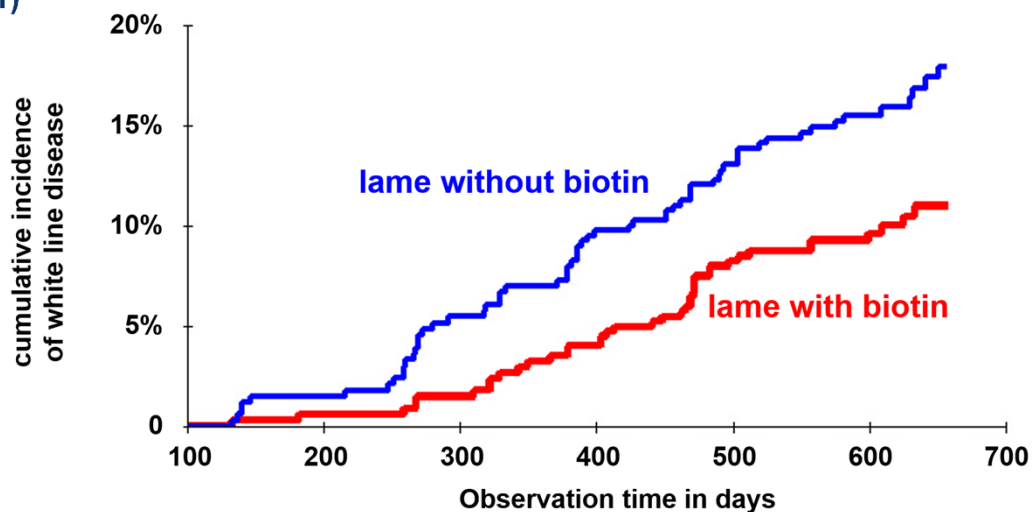
Clinical summary

Lesion / Study	Reference	Biotin dose	Response
White line Disease	Midla et al, (1998)	20 mg	Significant improvement in prevalence of white line lesions at 100 days of lactation
	Hedges et al, (2001)	20 mg	Biotin halved the risk of clinical lameness caused by white line lesions. Biotin supplemented animals required fewer repeat treatments (17.5% v. 30%)
Pasture fed Cattle	Fitzgerald et al, (2000)	20 mg	Supplemented herds had a significant reduction in lesions causing lameness



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The influence of 20 mg/day biotin supplementation on the incidence of clinical lameness caused by white line disease in dairy cattle (Hedges et al 2001)



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Feed Additives

- Rumen buffers (0.75% ration dry matter)
- Monensin (300 to 450 mg)
- Yeast products (levels as recommended)
- Organic zinc (1/3 of total zinc added)
- Biotin (15 to 20 mg/day)

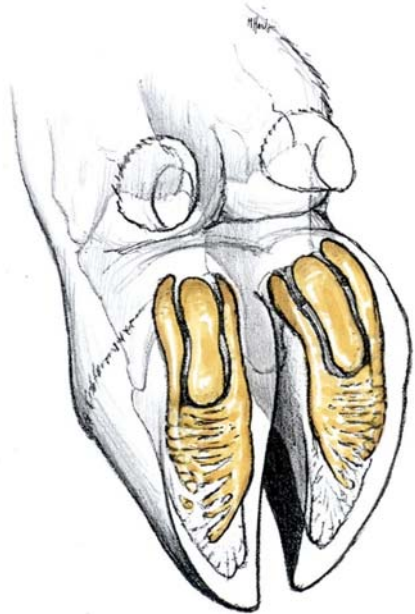


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Digital Cushion in Cows

- Cushions contain a higher amount of fat in mature cows compared to heifers
- Fat content is softer - contains a larger amount of MUFA (mono-unsaturated fat)

Ch. J. Lischer and P. Ossent,
12th International Lameness Symposium,
Orlando, FL, 2002.



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Impact of Changing Body Condition Score

- Digital cushion thickness (DCT) provides cushion to the hoof structure.
- Cows with the highest DCT had 15% lower lameness scores compared to lowest DCT scored cows.
- DCT continues to drop after calving with the lowest level at 120 days after calving
- Target: Avoid dropping more than 0.5 BCS after calving (reflects dry matter intake and environment)

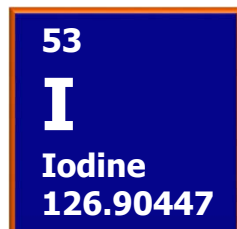


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What's New In Lameness Nutrition?

Impact of body condition score

Added iodine in
non-lactating
COWS



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Feeding Organic Iodine (EDDI)

- Ethylene diamine dihydroiodide
- Adding 3.8 ppm to the total ration DM (NOT ALLOWED FOR LACTATING COWS BY FDA)
- Feed this level for 60 to 90 days before lesions appear
- Response is earlier in younger animals
- Maximum level for lactating cows is 49.9 mg of EDDI / animal / day



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WI Steer Digital Dermatitis (DD) Study

- 120 Holstein steers from 300 to 595 lbs
- Added 3.8 ppm iodine as EDDI
- Results:

Item	Control	Iodine	
DD lesion (cm)	1.71	1.10	(P <0 .08)
M2* lesions (%)	55	30	< 0.11)

* M2 lesion: acute, active, and ulcer > 2.0 cm



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WU Heifer Study Digital Dermatitis (DD)

- 153 heifers were followed for 16 weeks
- All heifers were fed iodine for a minimum of 49 days
- 6.1% of control heifers had DD while iodine fed group had 2.5% DD ($P < 0.05\%$)
- Risk was 1.59 greater for control heifer to have DD
- Fewer repeat cases of DD with iodine



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Minimizing Lameness On The Farm

- Nutrition
- Cow comfort
- Footbath management
- Corrective hoof trimming



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Future

- Early detection - technology will help
- Cow comfort / hoof care programs--continue to improve cow's environment & management
- Nutrition--rumen health, BCS, PUFA, minerals, vitamins, and additives
- Genetics/Genomics/Gene technology--better feet and legs with hoof quality



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Recommended Reference

- <http://www.zinpro.com/lameness/dairy>
- Overlay of hoof structure
- Dairy and beef applications
- Excellent photos of hoof disorders
- Available as:
 - Book
 - Apple and Android Application



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In Summary

- Lameness is a highly visible and important animal welfare issue
- Failure to deal with it in timely fashion is partly a consequence of
 - A lack of awareness or a failure to detect
 - Inadequate facilities for examination & treatment



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Digital Dermatitis in the Dairy Herd

June 15, 2017

Four State Dairy Nutrition & Management Conference

Presented by:
Aerica Bjurstrom

Developed by:
Aerica Bjurstrom
UW-Extension Kewaunee County
&
Tina Kohlman
UW-Extension Fond du Lac County



What is digital dermatitis?

- Digital dermatitis (DD) (also known as hairy heel warts) affects heifers and cows
- Once a cow has it, she can never be cured, only managed
- First reported: Italy, 1974
- First appeared in the US in the early 1980s
- Rapidly spread in the mid 1990s
- Reported on 70% of *all* US dairies
- 95% of all dairies (500 cows or more)



Photo credit: Cornell University Extension

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Risk Factors

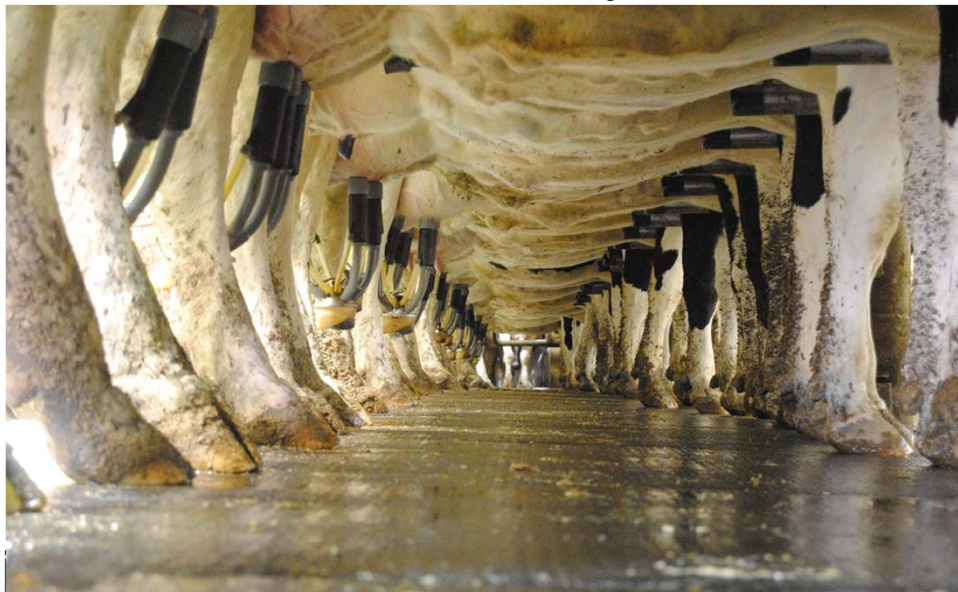
- Wet conditions
- Poor foot hygiene
- Presence of infected animals in the herd
- Poor footbath management
- High milk producing cows
- Early lactation
- Low parity
- Low heel height



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Field Study



Objectives

- Determine the prevalence of three primary stages of Digital Dermatitis (DD) on dairy operations.
 - M0 (no signs of lesion)
 - M2 (acute, active lesion)
 - M4 (chronic, nonactive lesion)
- Determine hoof health management practices regarding managing DD on eastern WI dairy operations.



Project Design



- Select group of cows on eastern WI dairy operations
- Small
 - 150 cows or less in tie-stall/stanchion barn
- Medium
 - Up to 700 cows in free-stall
- Large
 - more than 700 cows

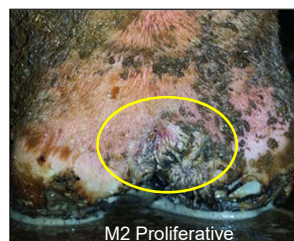


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What we were looking for...



M0



M2 Proliferative



M4 Hyperkeratotic



M4 Proliferative



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Herds Scored

- 11,817 observations
- 45 herds
 - 15 small
 - 19 medium
 - 11 large
- Smallest herd 22 cows
- Largest herd 6,700 cows
- Average size 607 cows
- Small
 - 22-115 cows
 - Average 63 cows
 - 100% scored
- Medium
 - 70-590 cows
 - Average 257 cows
 - Average 84% scored
- Large
 - 850-6,200 cows
 - Average 1,955 cows
 - Average 43% scored

Prevalence of Digital Dermatitis in Select Group of Cows on Surveyed Eastern WI Farms



Lesion	Number of Cows	% Cows Scored	Avg per Farm (%)	Min (%)	Max (%)
				Range	
M0	9,591	81.1	76.0	49	100
M2	212	1.8	3.5	0	27
M4	2,014	17.1	20.1	0	50
Total	11,817				

Prevalence of Digital Dermatitis in Select Group of Cows on Surveyed Eastern WI Farms

Herd Size	Low (≤ 5)	Moderately Low (5-10%)	Moderately High (10-25%)	High ($\geq 25\%$)
Small	13.3	13.3	26.7	46.7
Medium	10.5	0.0	26.3	63.2
Large	36.4	9.0	27.3	27.3
Total	17.8	6.7	26.7	48.9

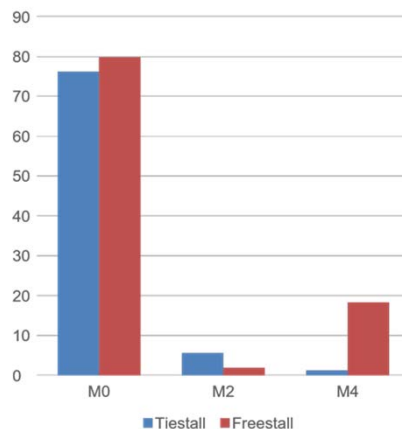
Goal is to have a low ($\leq 5\%$) prevalence of DD within a group of cows

Nearly 18% of surveyed operations (n=8) had $\leq 95\%$ healthy feet within select group of cows

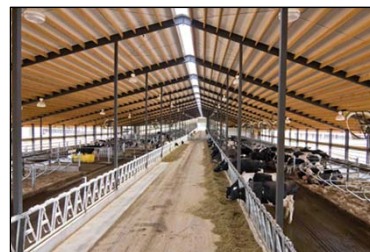


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Prevalence of Digital Dermatitis in Select Group of Cows on Surveyed Tiestall Barns



Tiestall (n=15), 917 cows



Freestall (n=30) 10,900 cows



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Prevalence of Digital Dermatitis in Selected Group of Cows on Surveyed Eastern WI Farms

Footbath Frequency



Footbath Frequency	Operations	M0 (%)	M2 (%)	M4 (%)
No footbath	11	71.5	6.9	21.5
1 to 3 times per week	16	74.1	3.1	22.8
4 to 7 times per week	13	79.6	1.7	18.4

Footbath length recommendations: 10-12 feet
Average length from participating farms on field survey: 6' 9"



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Prevalence of Digital Dermatitis in Selected Group of Cows on Surveyed Eastern WI Farms

Hoof Trimming Frequency

	Operations	M0 (%)	M2 (%)	M4 (%)
(Bi)Weekly	11	82.9	1.1	16.0
(Bi)Monthly	16	70.1	5.3	24.6
Quarterly	8	72.9	3.0	24.0
(Bi)Annually	7	76.1	7.0	18.4



Image Source: Birkelmann's Welding



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Prevalence of Digital Dermatitis in Selected Group of Cows on Surveyed Eastern WI Farms

Treatment Type

Treatment	Operations	M0 (%)	M2 (%)	M4 (%)
Spray	7	74.4	5.4	20.1 ^b
Treatment with footwrap	32	78.5 ^a	3.1	18.4 ^{b,c}
Treatment without wrap	6	65.0 ^a	4.0	29 ^c



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Take Back to the Barn



- Prevalence of DD in tiestall and freestall operations was similar
- Concentration of footbath solution, trimming frequency, and treatment type had an impact on stage and chronicity of DD lesion



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Prevalence of Digital Dermatitis in Eastern Wisconsin Dairy Herds

<http://fyi.uwex.edu/dairy/>

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Questions?