

# Improved detection of lameness

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Thanks: Dairy Farmers of Canada, NSERC, Animal Compassion  
Foundation.



THE  
UNIVERSITY OF  
BRITISH  
COLUMBIA



animal welfare  
program



Agriculture and  
Agri-Food Canada

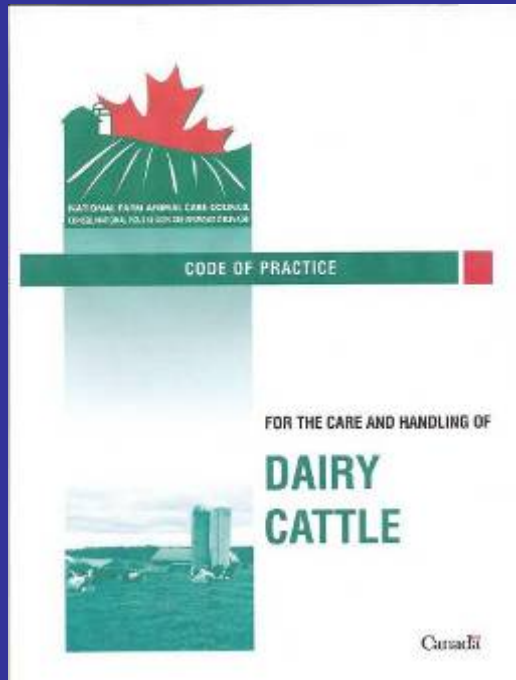
Agriculture et  
Agroalimentaire Canada

Canada



**NATIONAL FARM ANIMAL CARE COUNCIL**  
**CONSEIL NATIONAL POUR LE SOIN DES ANIMAUX D'ÉLEVAGE**

[www.nfacc.ca](http://www.nfacc.ca)



## Code of Practice for the Care and Handling of Dairy Cattle

**Committee:** Dairy producers, veterinarians, animal transporters, animal welfare groups, researchers, CFIA, food retailers

Based on scientists' review of research done on dairy welfare (available at [www.nfacc.ca](http://www.nfacc.ca))

# Lameness is one of the most serious and prevalent problems for farm animals

Lameness is a common welfare problem for farm animals selected for high growth rates or high milk production

Dairy cows: prevalence 15 - 30%

Breeding sows: prevalence 9 -15%

Growing pigs: 11%

Broilers: 28%

Measures of prevalence or incidence of lameness are common animal welfare indicators used in animal welfare monitoring



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**Requirement:** Lame cows must be diagnosed early, and either treated, culled or euthanized

**Recommended BP:** Routinely observe cows for lameness and aim for a prevalence of less than 10% of severe lameness



Dermatitis

## Infectious causes of lameness

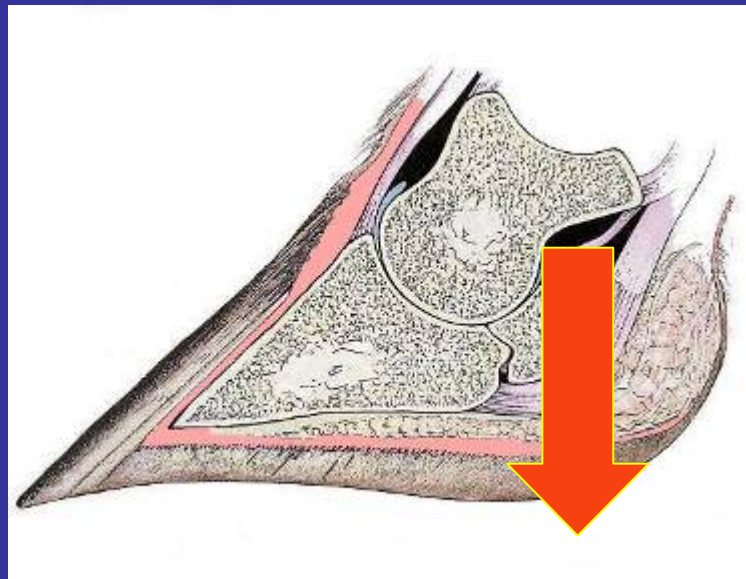


Heel erosion

# Lameness due to claw horn disruption



Ulcers have their origin following the descend of the pedal bone, which exerts pressure on the corium



# Cows' hooves evolved for walking on soft surfaces like pasture



**But in North America most cows now stand on concrete**



# Dairy farmers have problems detecting lameness

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On average, dairy producers are aware of

1 lame cow out of 3.1 lame cows: Espejo et al 2006 Minnesota

1 lame cow out of 3.88 lame cows: Whay et al 2003 UK

# Dairy farmers have problems detecting lameness

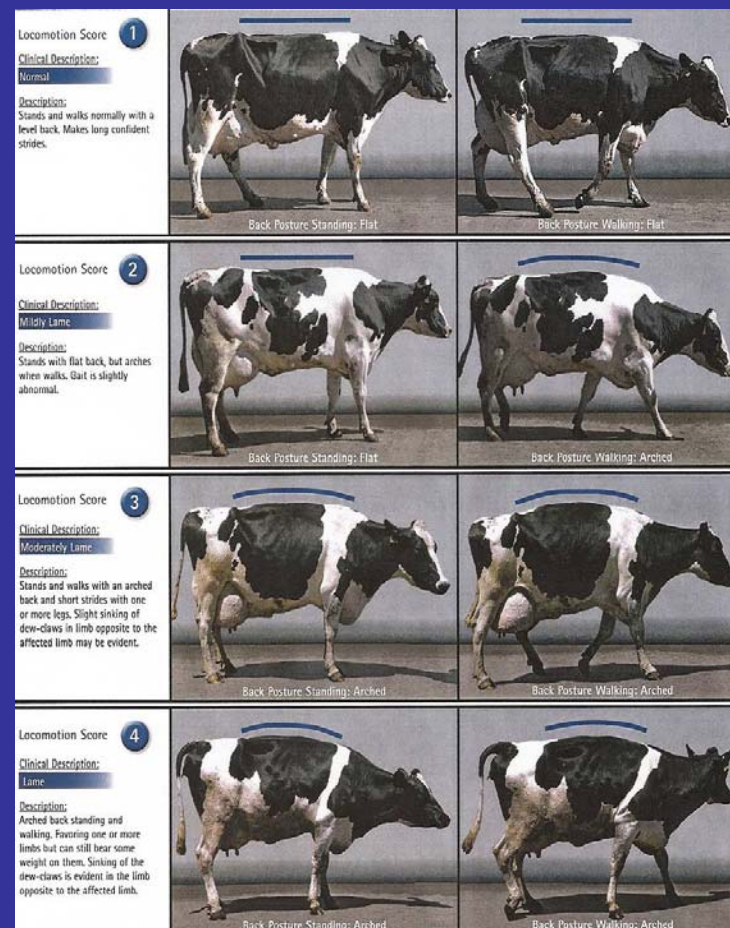
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- "abnormal becoming normal"
- large farms with few workers
- cows walking on bad flooring
- lack of awareness of how gait changes with lameness

NEED BETTER METHODS OF DETECTING  
LAMENESS

# Current gait scoring methods:

1. Sometimes low reliability
2. Often highly subjective and poorly described e.g. "moderately lame" or use only limited number of specific behaviours e.g. back arch
3. Often not validated - poor ability to detect animals with lesions or injuries



1

2

3

4

5

Not lame

(lame)

severely lame

Arch back



Flat

Convex

Combined to give an overall score

Spinal arch

Head bob



Asymmetric steps

Reluctance to bear weight

Tracking up

Joint flexion

Swinging in/out

Flower, F and Weary, D. M. JDS 2006 89: 139

## Reliability (correlations) between and within-raters

	Intra-rater	Inter-rater
Bear weight	.95	.79
Back Arch	.93	.77
Tracking	.92	.80
Asymm steps	.91	.72
Head bob	.83	.79
Joint flexion	.90	.58
Swing out	.68	

Video- asymmetric stepping  
reluctance to bear weight

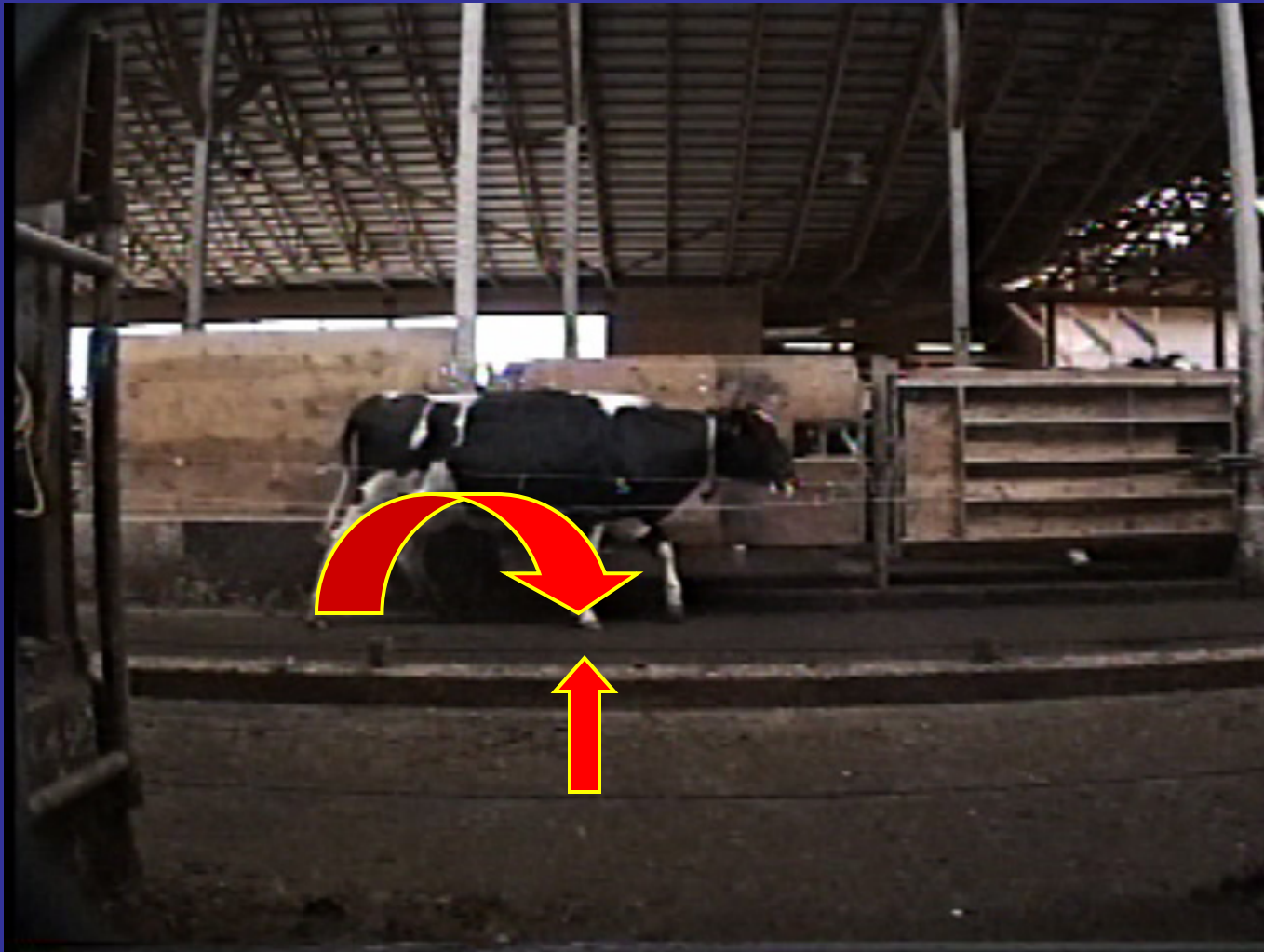


Favoring one leg over another

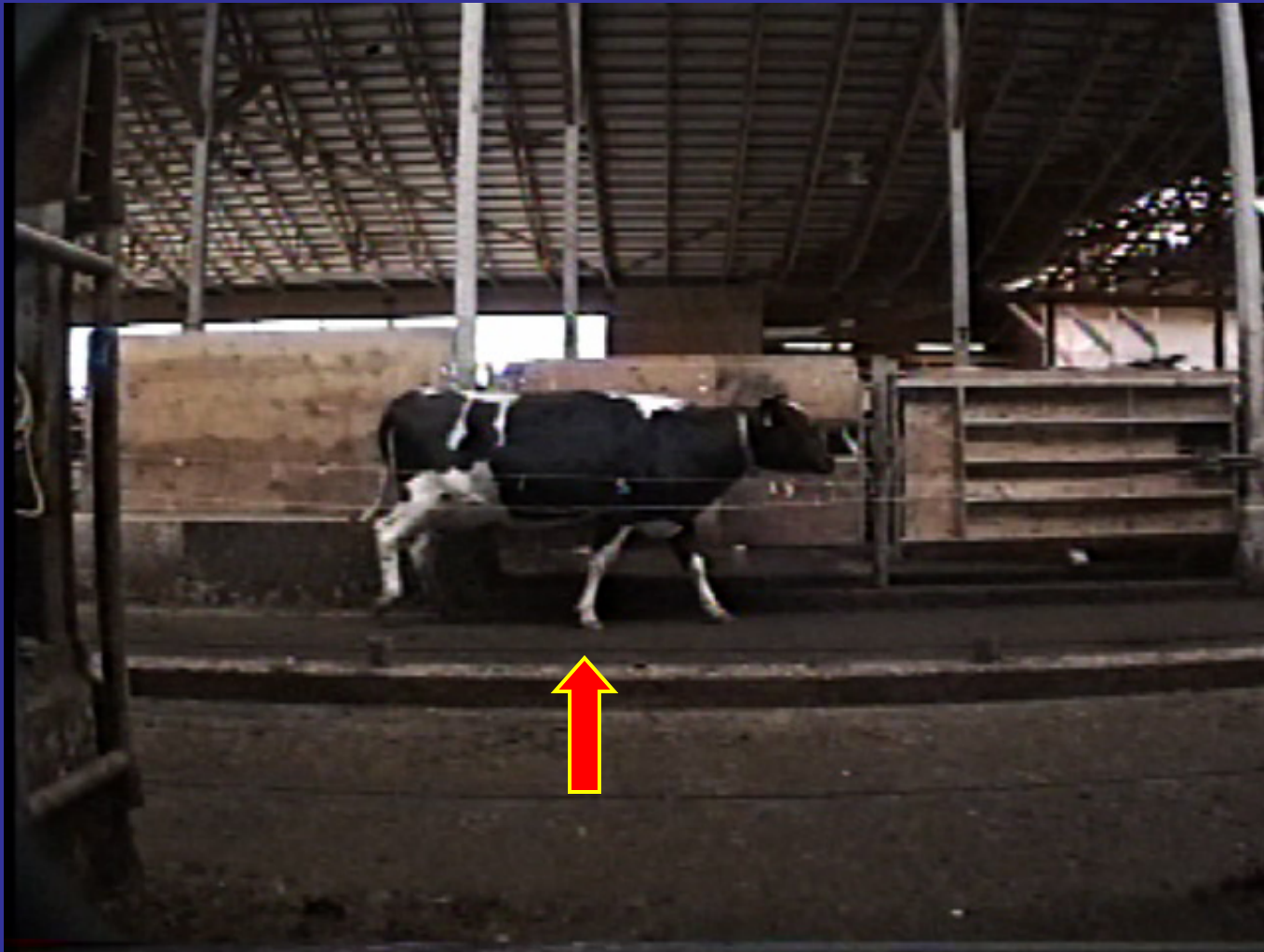
# Arched back

<p>Locomotion Score <b>1</b></p> <p><u>Clinical Description:</u> Normal</p> <p><u>Description:</u> Stands and walks normally with a level back. Makes long confident strides.</p>	 <p>Back Posture Standing: Flat</p>	 <p>Back Posture Walking: Flat</p>
<p>Locomotion Score <b>2</b></p> <p><u>Clinical Description:</u> Mildly Lamé</p> <p><u>Description:</u> Stands with flat back, but arches when walks. Gait is slightly abnormal.</p>	 <p>Back Posture Standing: Flat</p>	 <p>Back Posture Walking: Arched</p>
<p>Locomotion Score <b>3</b></p> <p><u>Clinical Description:</u> Moderately Lamé</p> <p><u>Description:</u> 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.</p>	 <p>Back Posture Standing: Arched</p>	 <p>Back Posture Walking: Arched</p>
<p>Locomotion Score <b>4</b></p> <p><u>Clinical Description:</u> Lamé</p> <p><u>Description:</u> 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.</p>	 <p>Back Posture Standing: Arched</p>	 <p>Back Posture Walking: Arched</p>

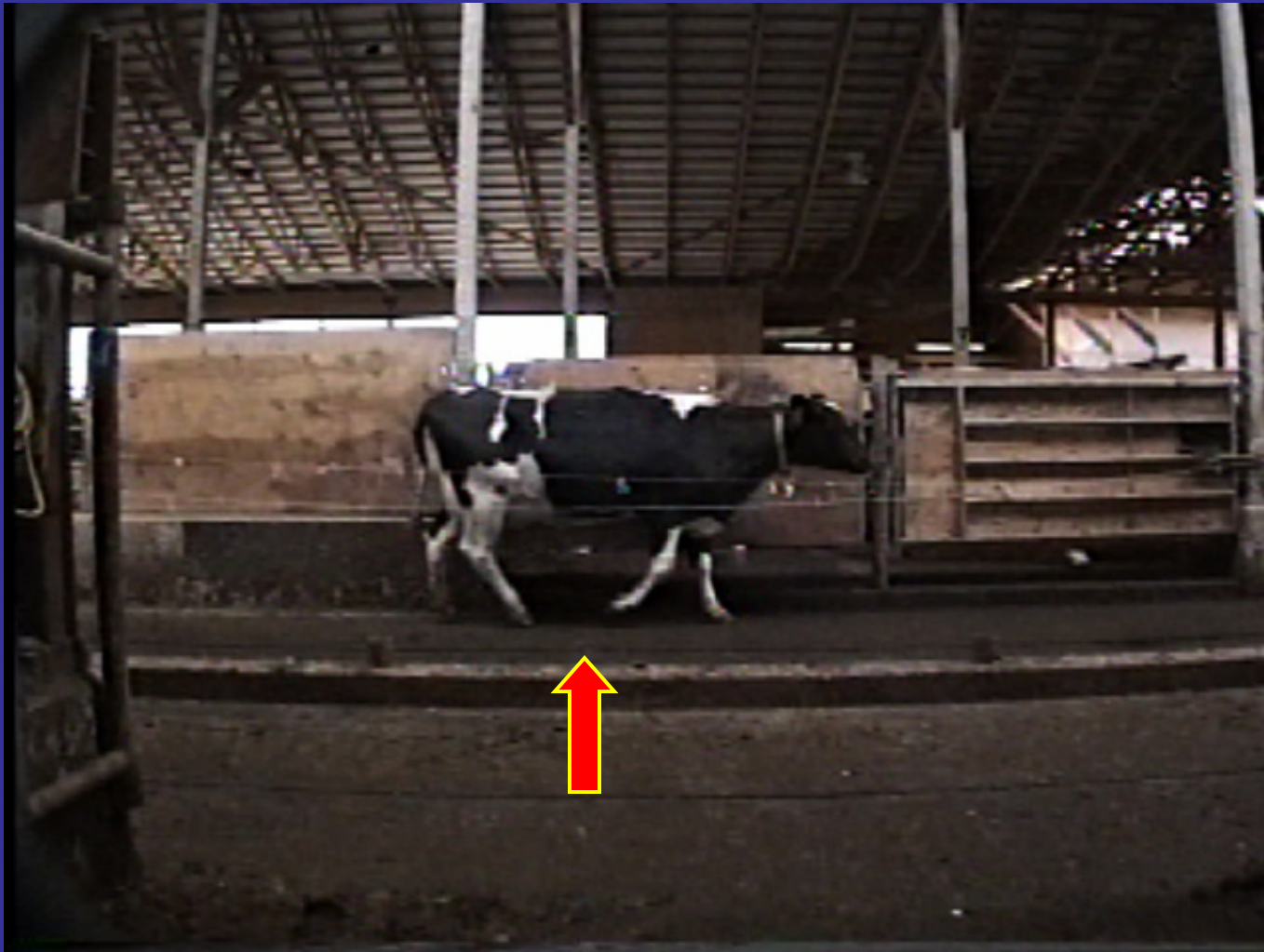
# Tracking up - cow with healthy feet



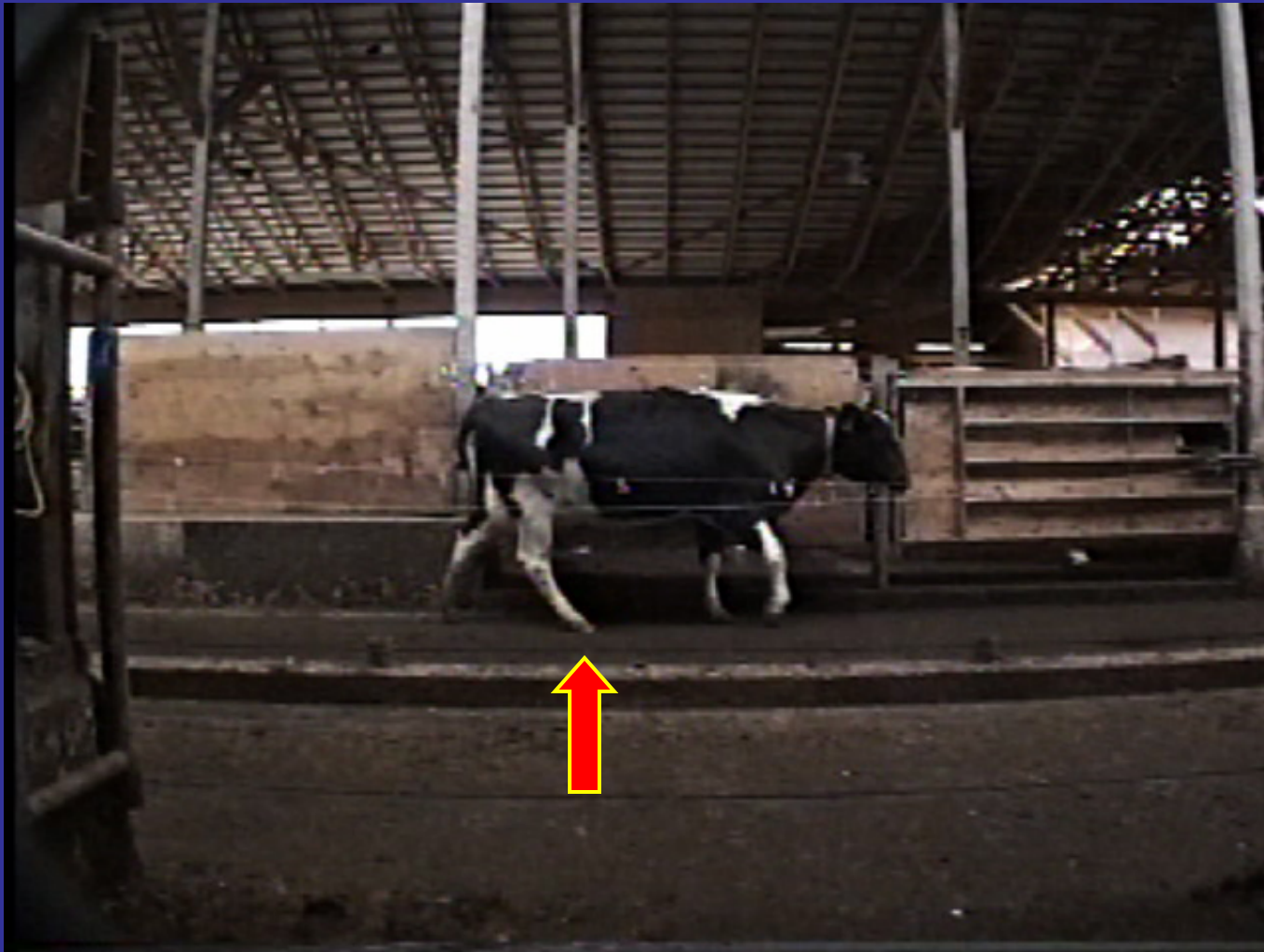
# Cow with healthy feet



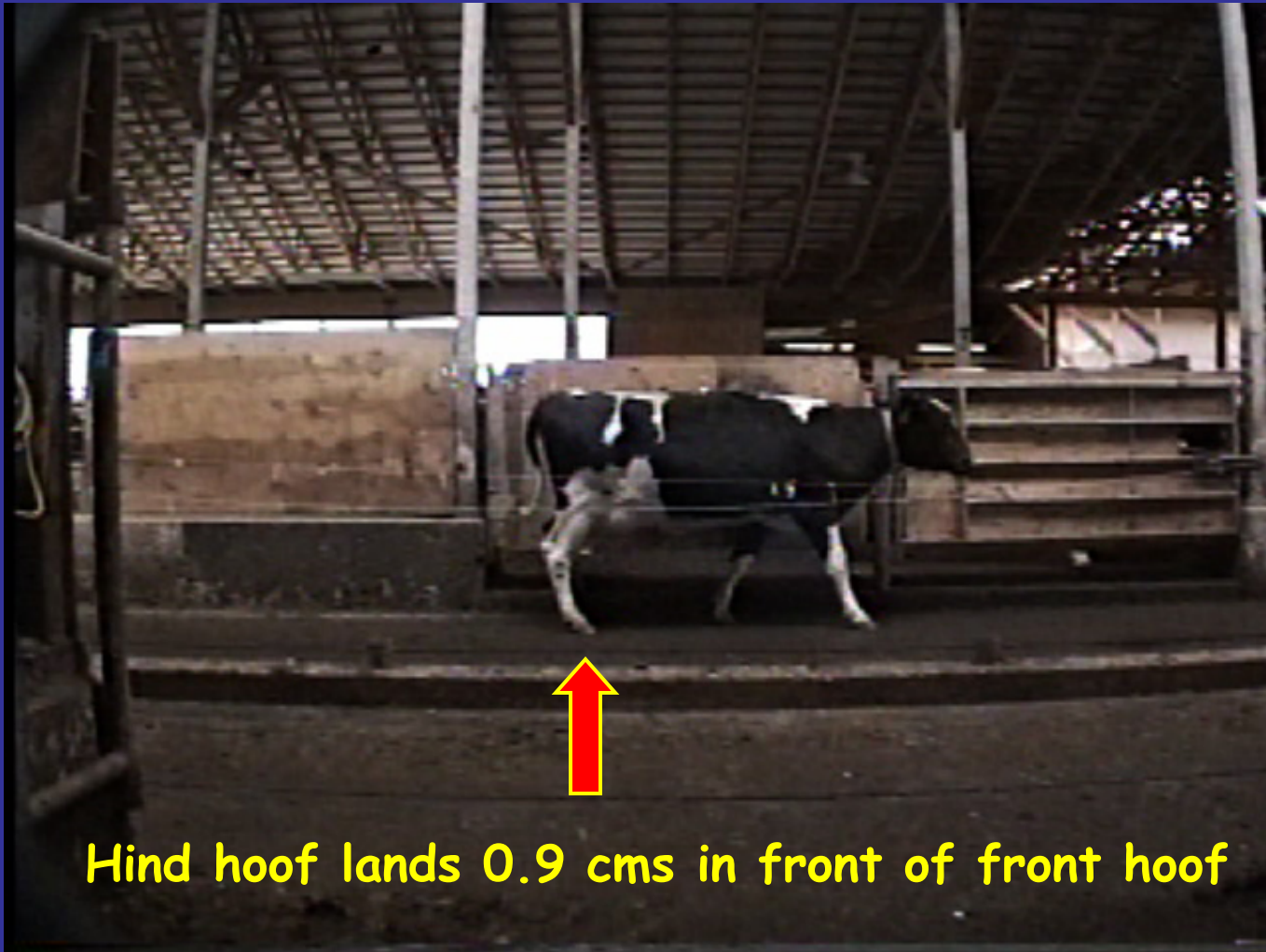
# Cow with healthy feet



# Cow with healthy feet

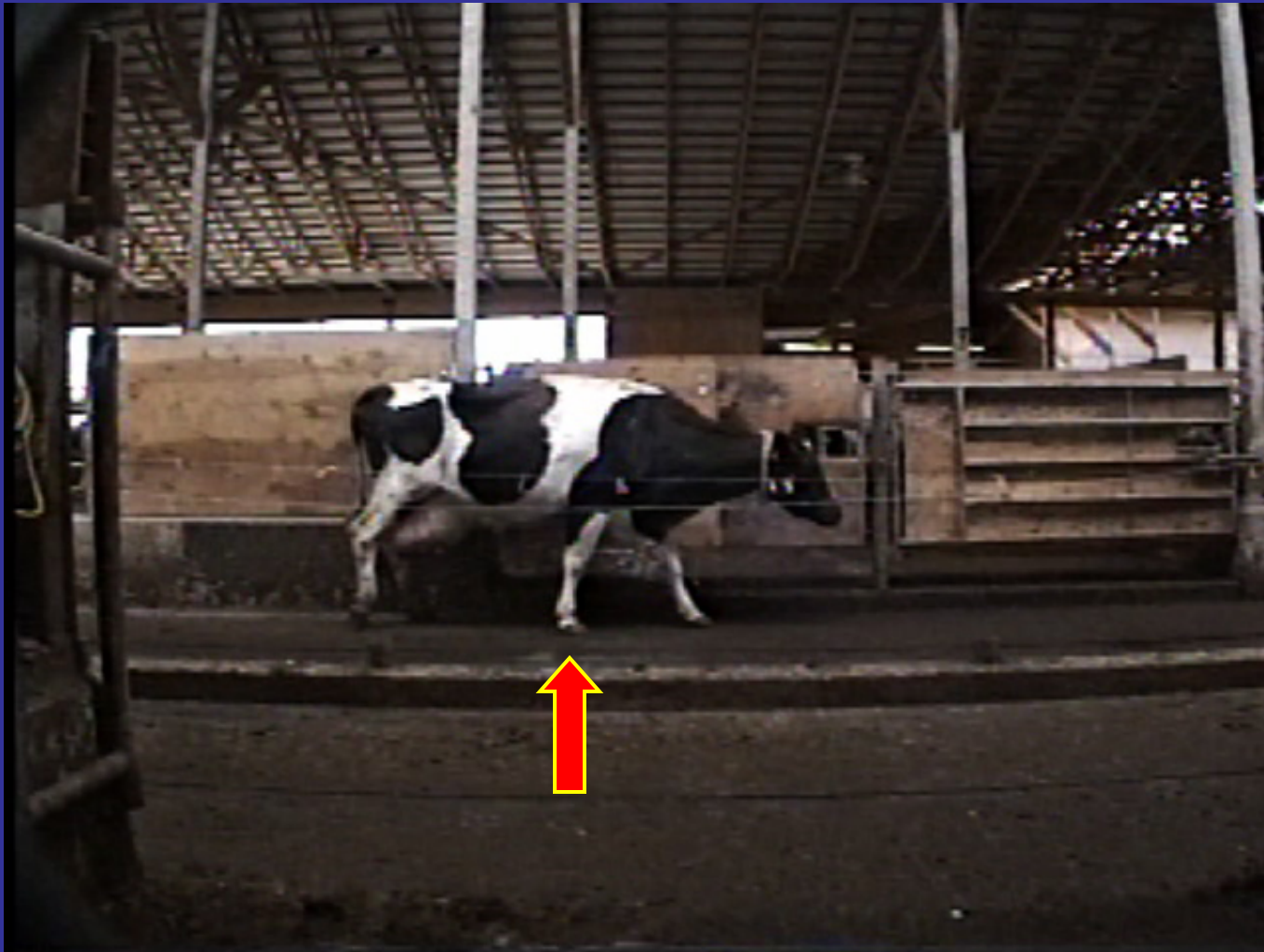


# Cow with healthy feet



Hind hoof lands 0.9 cms in front of front hoof

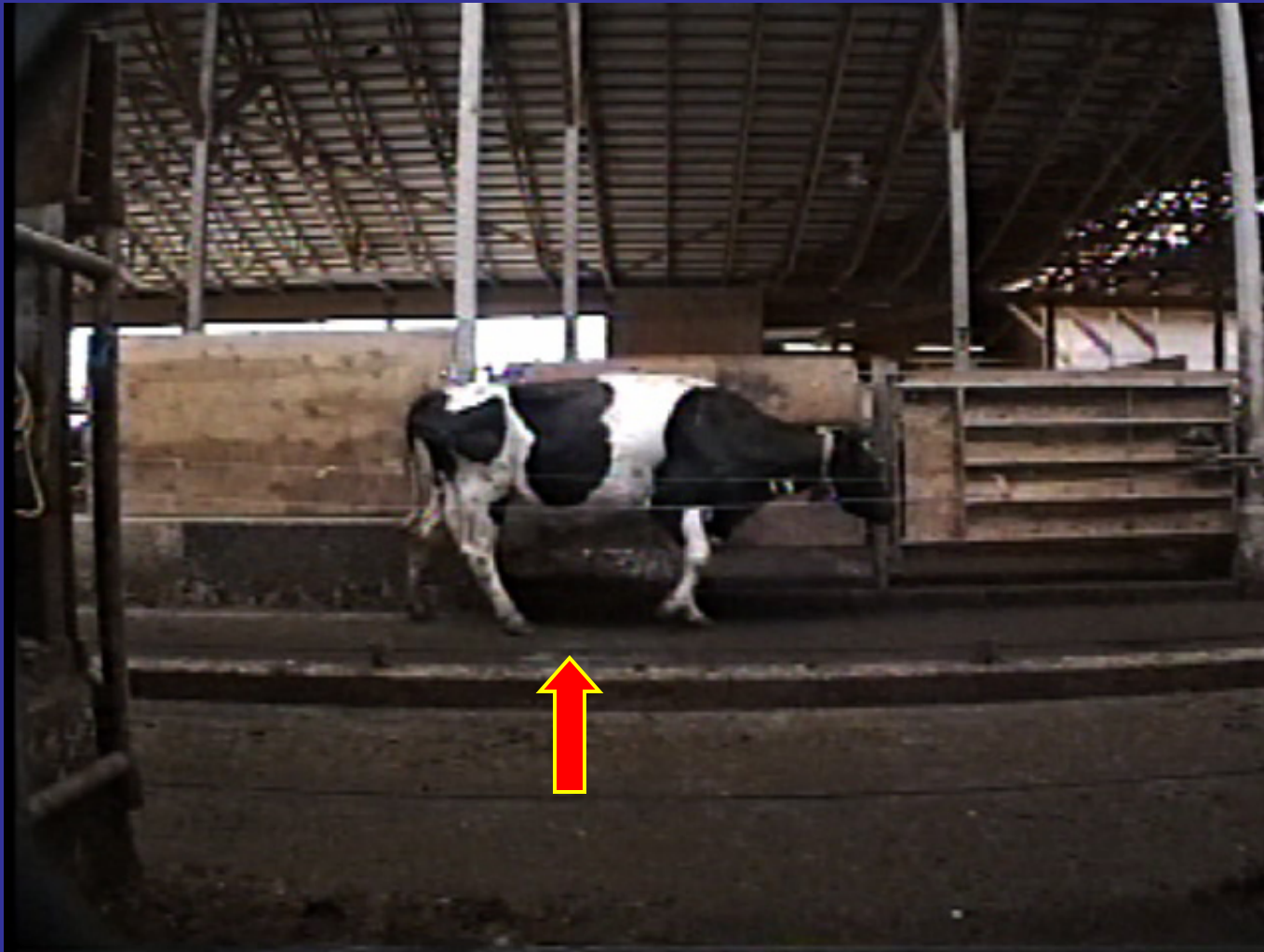
# Poor tracking up- Cow with sole ulcer



# Cow with sole ulcer



# Cow with sole ulcer



# Cow with sole ulcer

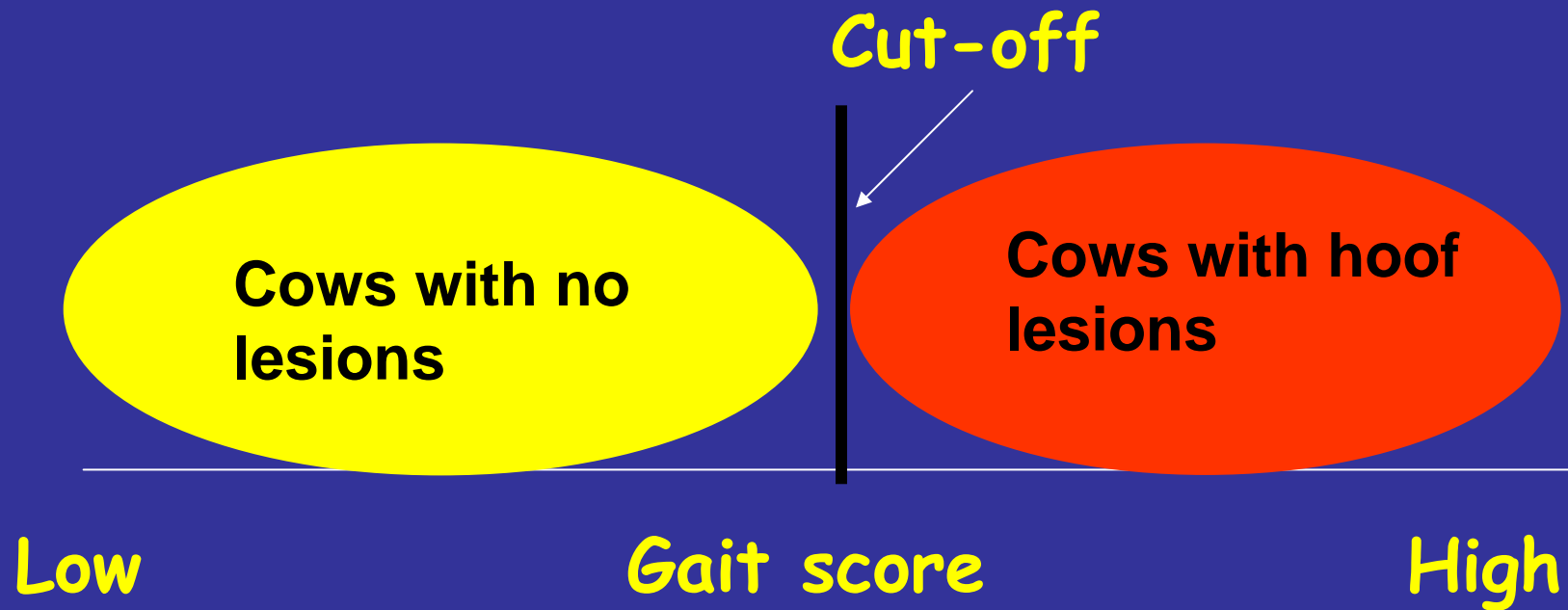


Hind hoof lands 4.3 cms *BEHIND* front hoof

Can gait scoring detect cows with sole lesions?

-which changes in gait are the best at doing this?

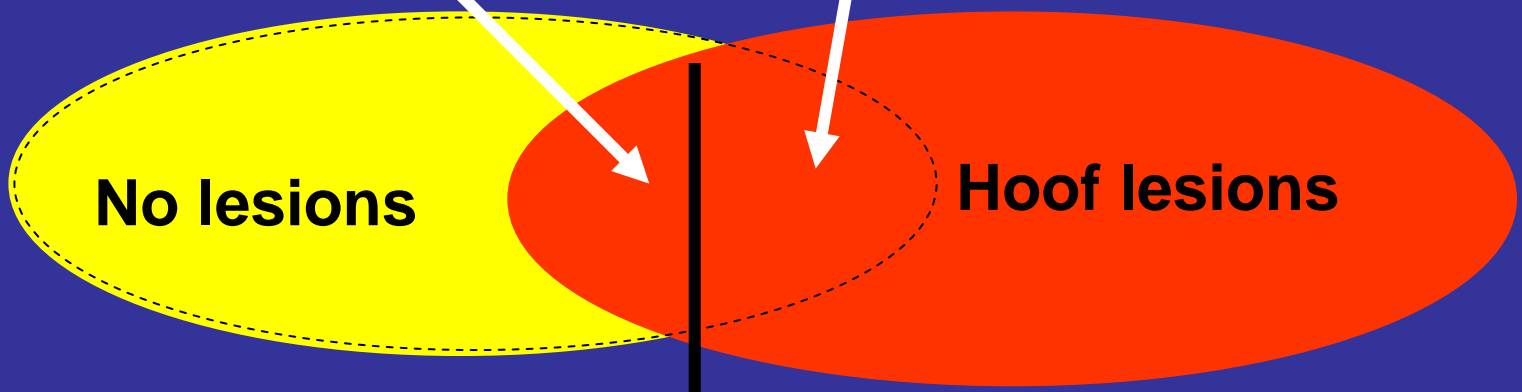
# What we want



# What we get

"False negatives"

"False positives"



No lesions

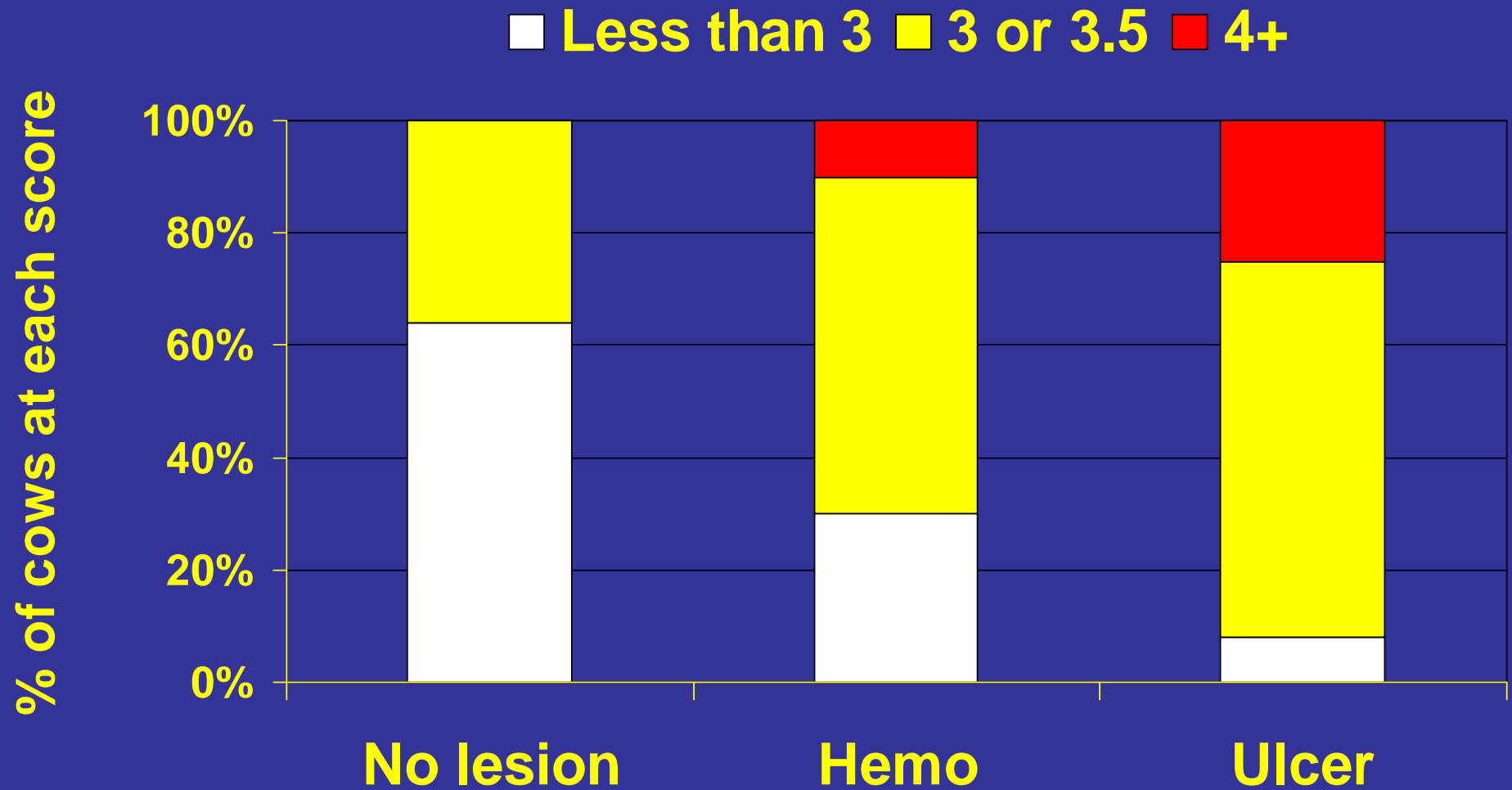
Hoof lesions

Low

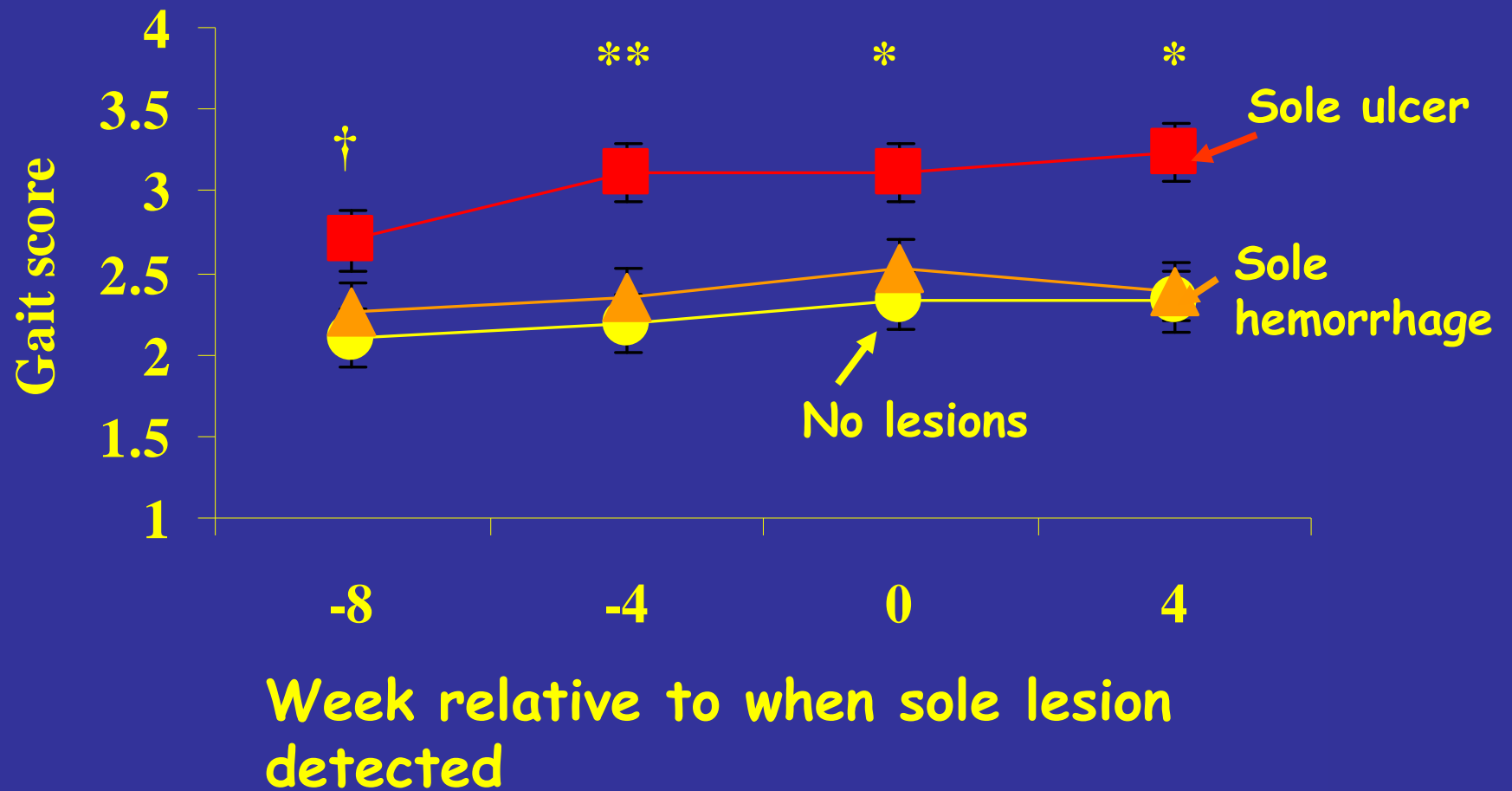
Gait score

High

# Percent of cows with each type of lesion that have a certain gait score



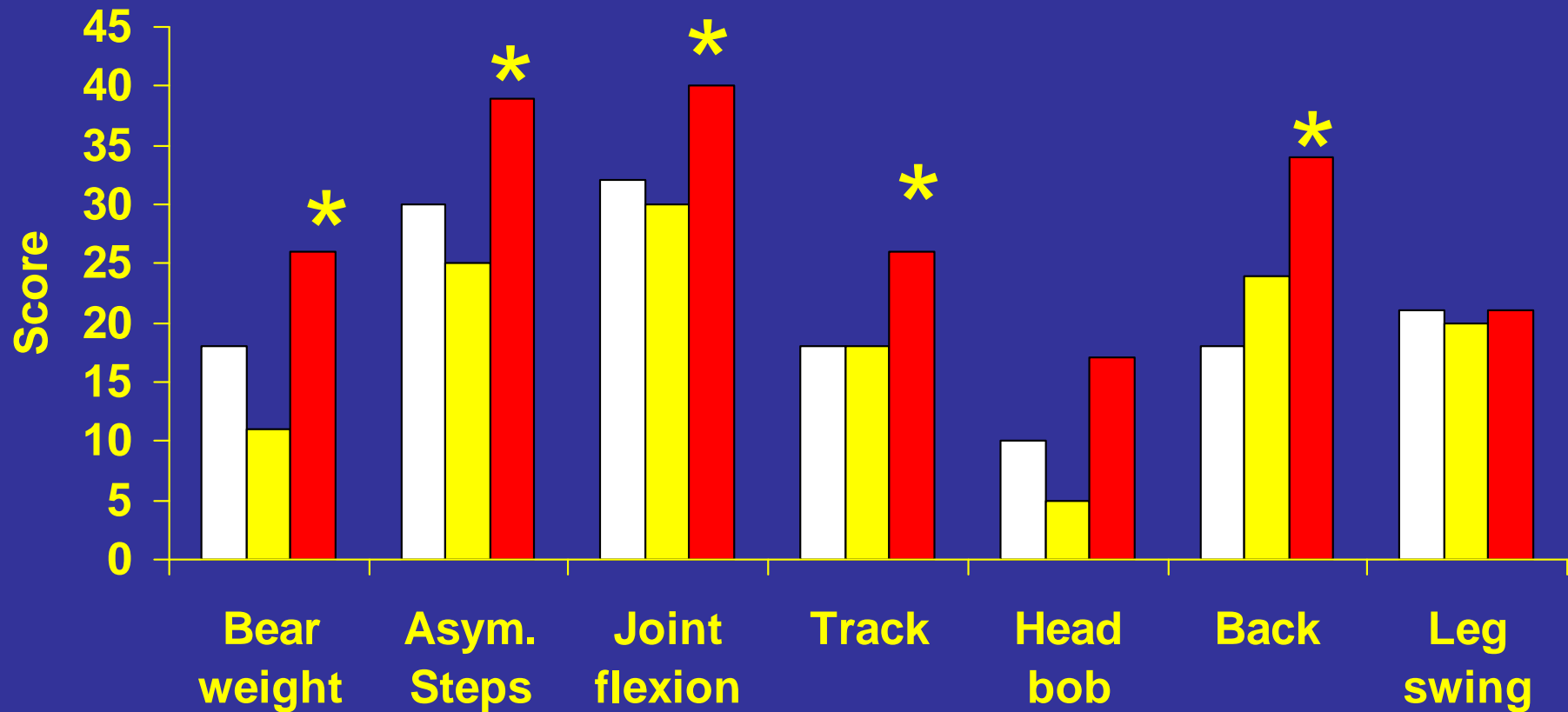
# Changes in gait occur before the sole lesion is visible on the hoof



# Which components of the gait best predict the presence of sole ulcers and hemorrhages?

\* Difference from cows with no lesions  $p < 0.05$

■ No lesions ■ Hemorrhage ■ Ulcers



## Which components of the gait best predict the presence of sole ulcers?

Reluctance to bear weight	Characteristic of most cows with ulcers- easy to see
Asymmetric steps	Characteristic of most cows with ulcers- easy to see
Back arch	Extreme is characteristic of <u>some</u> cows with ulcers- easy to see
Head bob	Not very reliable- not a good sign of ulcers
Tracking	affected by walking speed
Joint flexion	not easy to see
Leg swing	Not a good sign of ulcers- affected by time since milking



Introduction: Lameness — How Big is the Problem?



Gait Scoring: Identifying Degrees of Lameness



Identifying Hoof Injuries and Disease

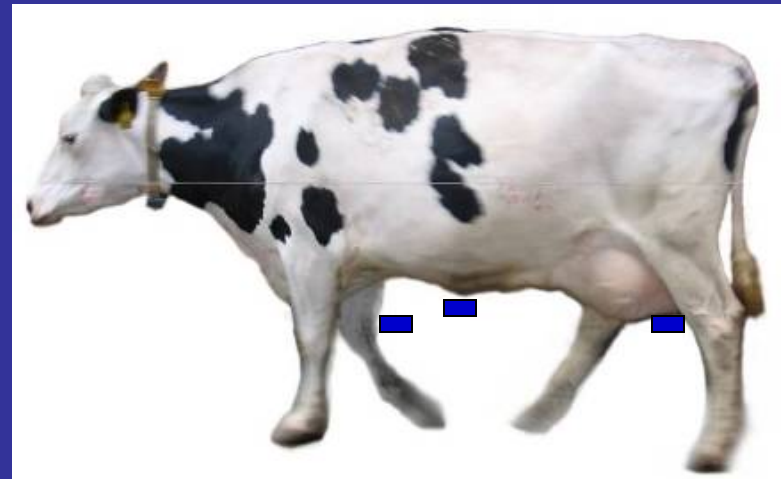


Conclusion: What Now? What's Next?

RENEWAL.  
the way to  
grow

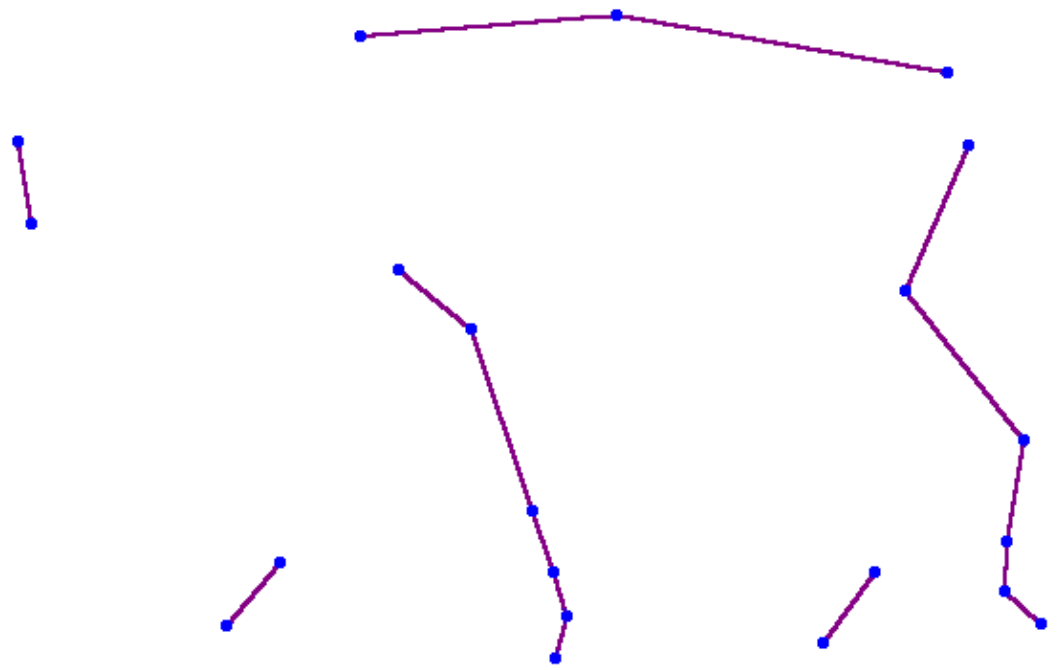
# Firm Steps: Identifying Lameness in Dairy Cattle

# Gait scoring can be improved through a better description of how cows walk and how gait changes with lameness



Kinematic analysis- Frances Flower

# Computer simulation of a cow walking: Frances Flower, UBC



# Cows with sole ulcers

- Walk more slowly (4.21 km/h vs 4.36km/h)
- With lower (8.8cm vs 9.6cm) and shorter (1.49m vs 1.52m) strides
- More time with three hooves on the ground at once (73.8% versus 69.7%)
- Worse 'tracking up''

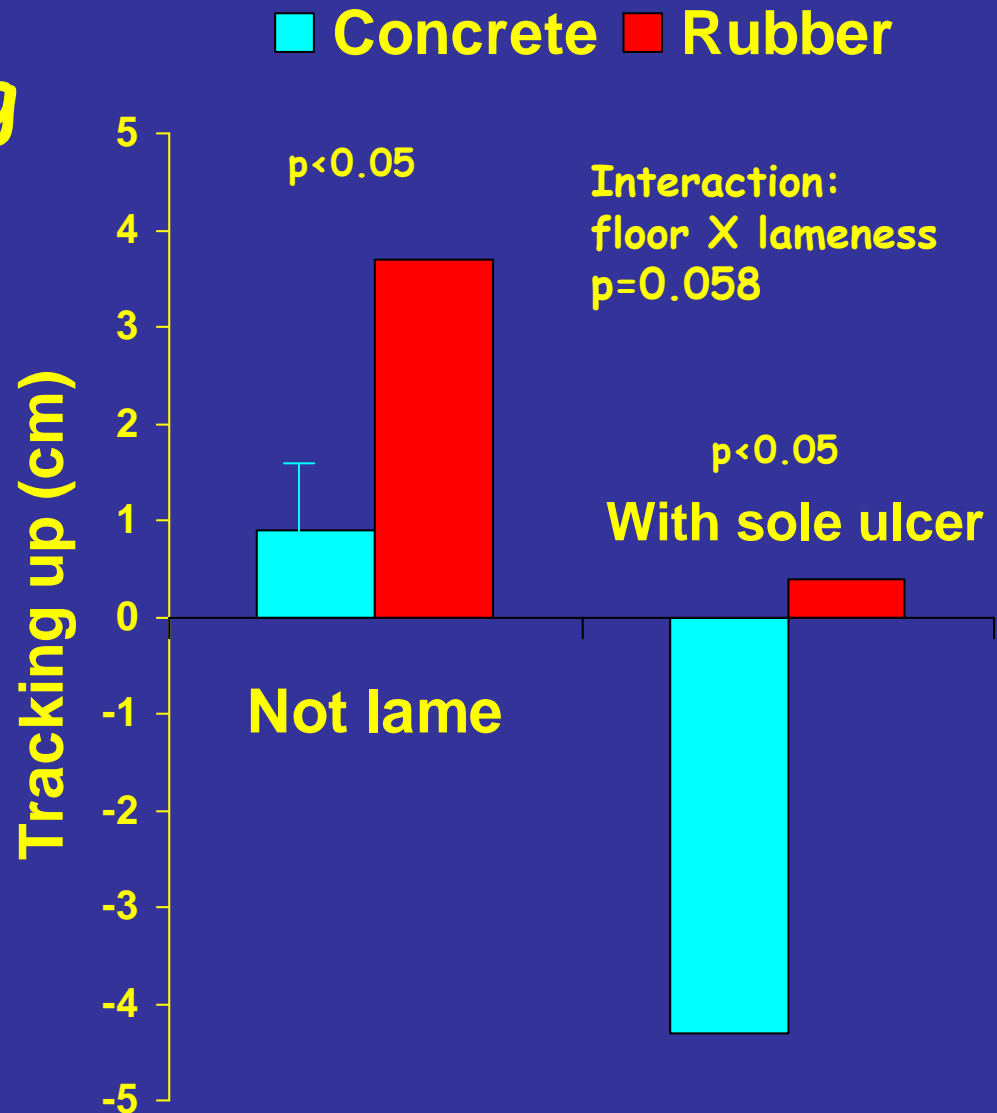
Flower, F, de Passille, A. M., Weary, D, M, Sanderson, D. J., Rushen, J. (2007)  
Softer, higher-friction flooring improves gait of cows with and without sole ulcers. J. Dairy Sci. 90: 1235-1241

**Cows with sole ulcers show poorer tracking than cows with no lesions**

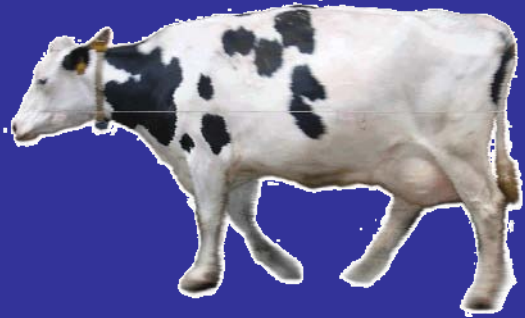


(Flower et al. 2007 JDS 90:1235)

Softer flooring  
improves tracking  
up especially of  
lame cows



(Flower et al. 2007 JDS 90:1235)



## Can gait scoring detect the degree of pain underlying lameness?

6 cows with identified lameness in one leg

6 cows with normal gait and no visible sole lesions

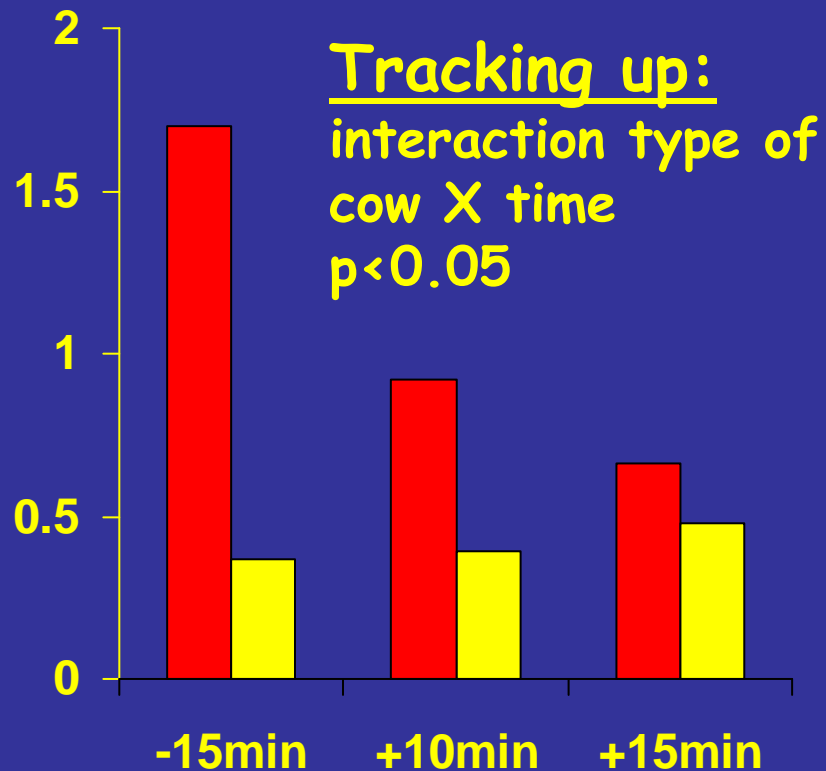
Lidocaine injected into injured (or matched) leg

Gait scored 15 mins before, 10 min after and 15 mins after injections

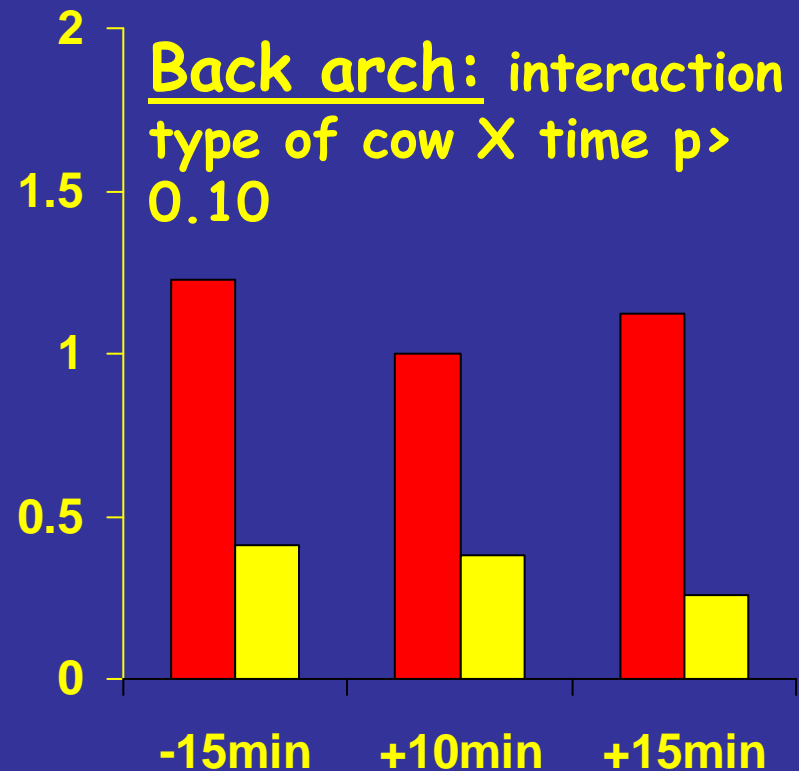
Rushen, J., Pombourcq, E. and de Passillé, A. M. (2007) Validation of two measures of lameness in dairy cows. Applied Animal Behaviour Science 106, 173-177

# Local anaesthetic significantly improved some (but not all) components of gait of lame cows

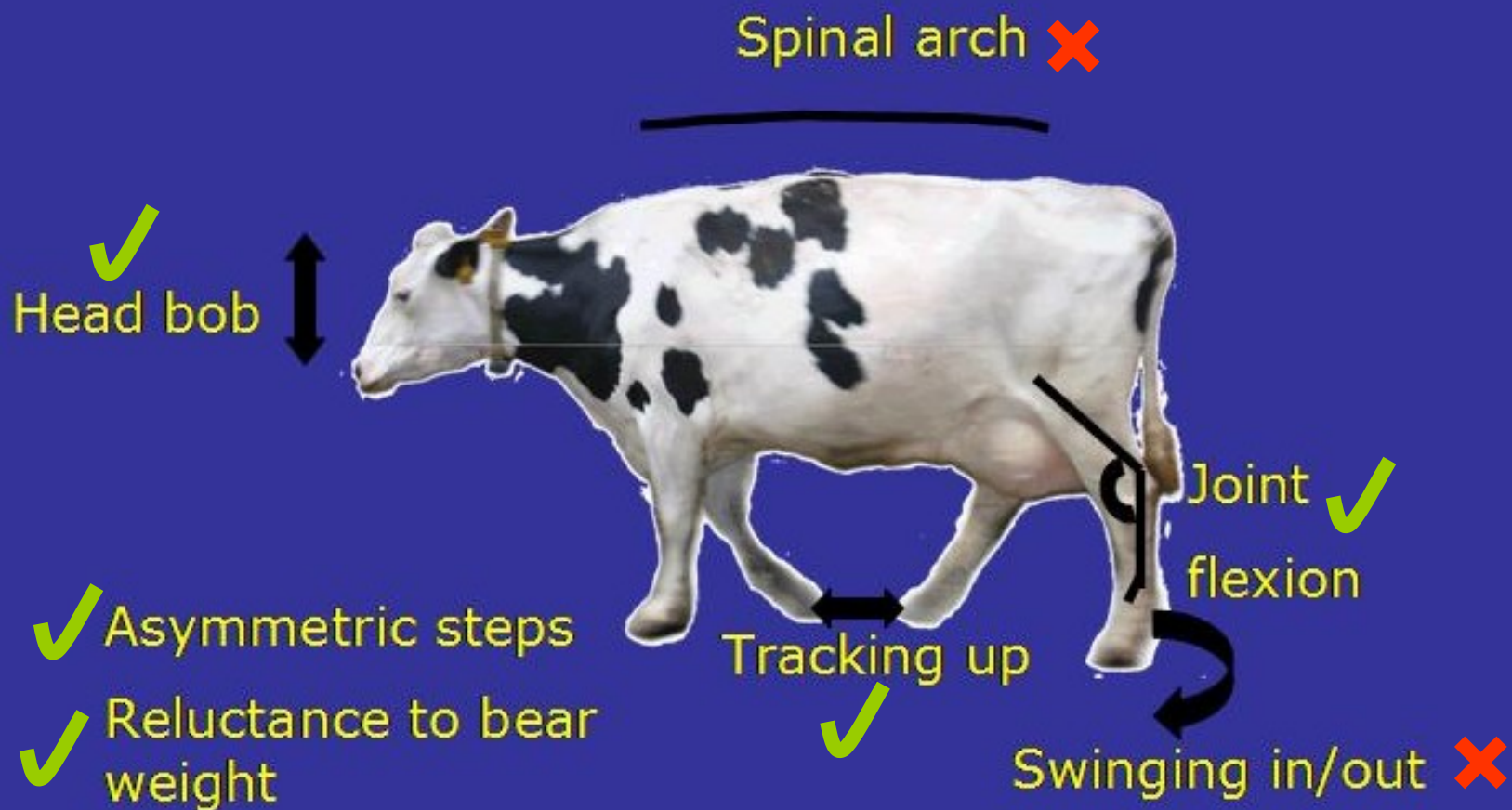
■ Lame ■ Healthy



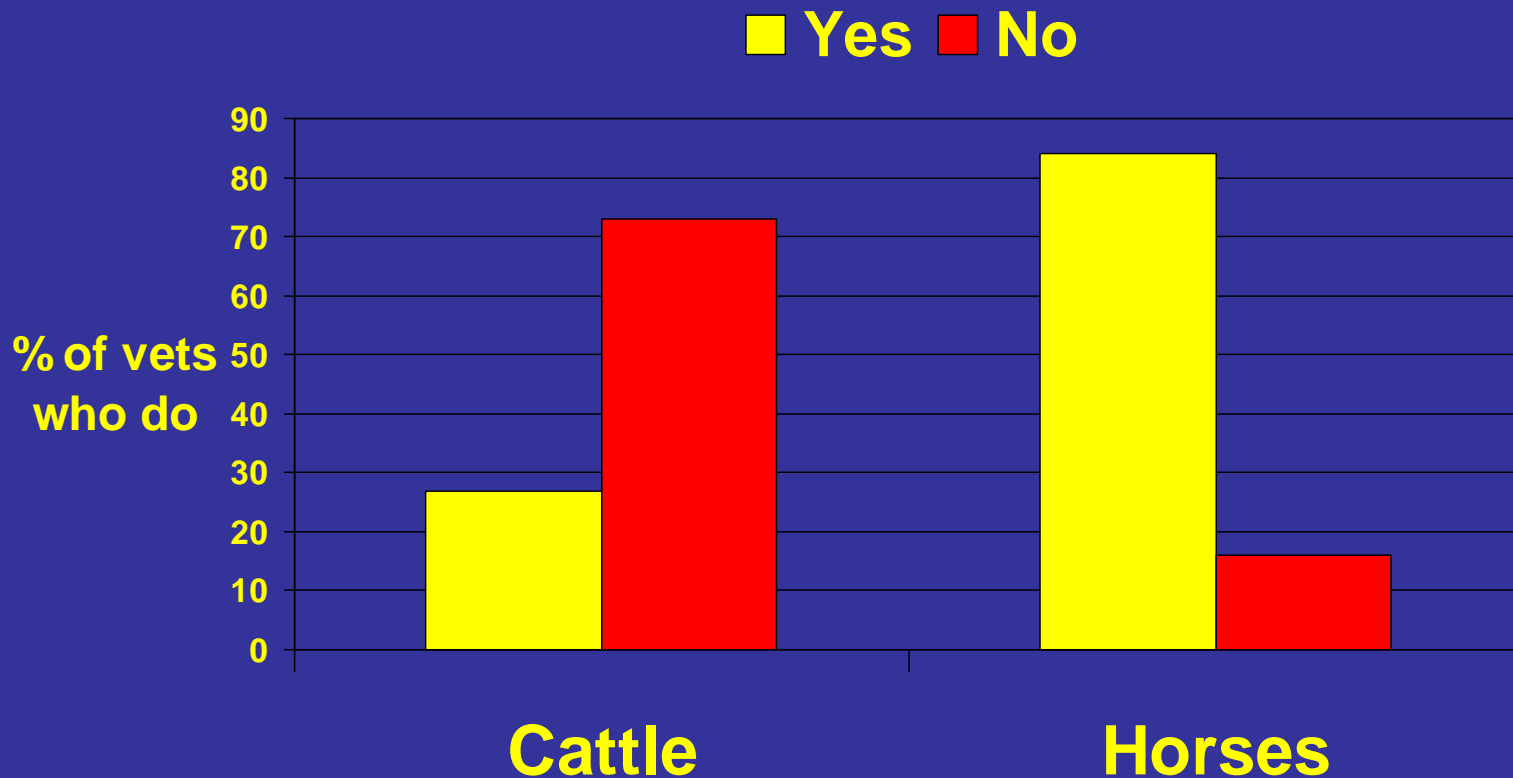
■ Lame ■ Healthy



Most of the components of gait were significantly ( $p < 0.05$ ) reduced by lidocaine



# Are analgesics prescribed for lameness (UK) ?



O'Callaghan Lowe et al., 2004 J. Vet. Med.A. 51:429

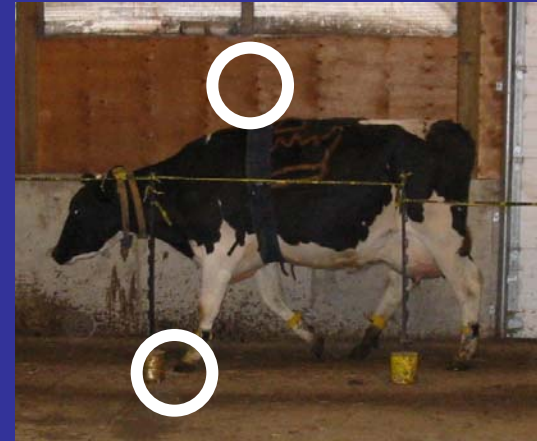
# Automated detection of lameness



Automated milking systems



Measures of weight distribution



Accelerometers

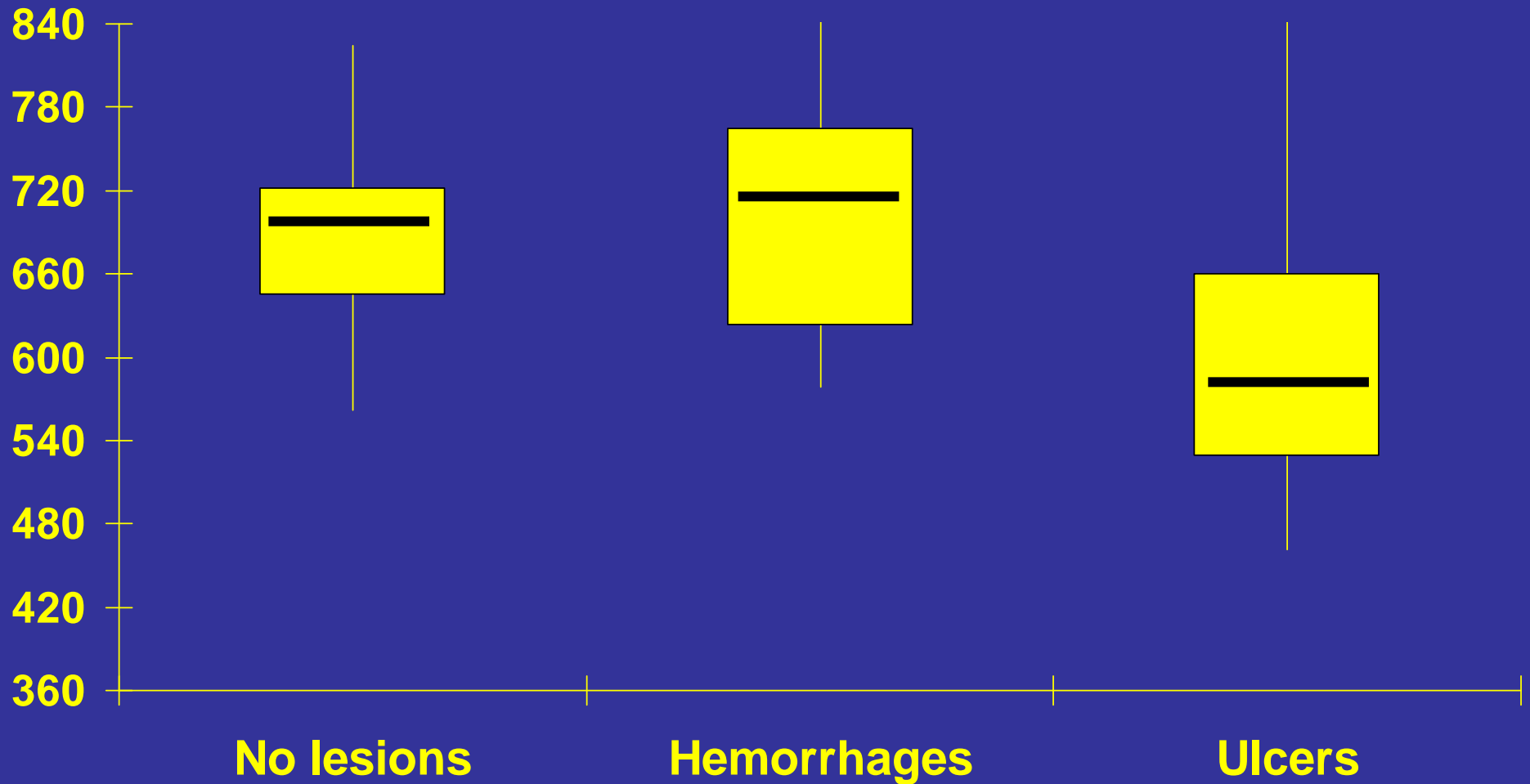
# Automated detection of changes in cows' activity

Devices attached to a cows leg to measure time standing and lying and number of steps taken

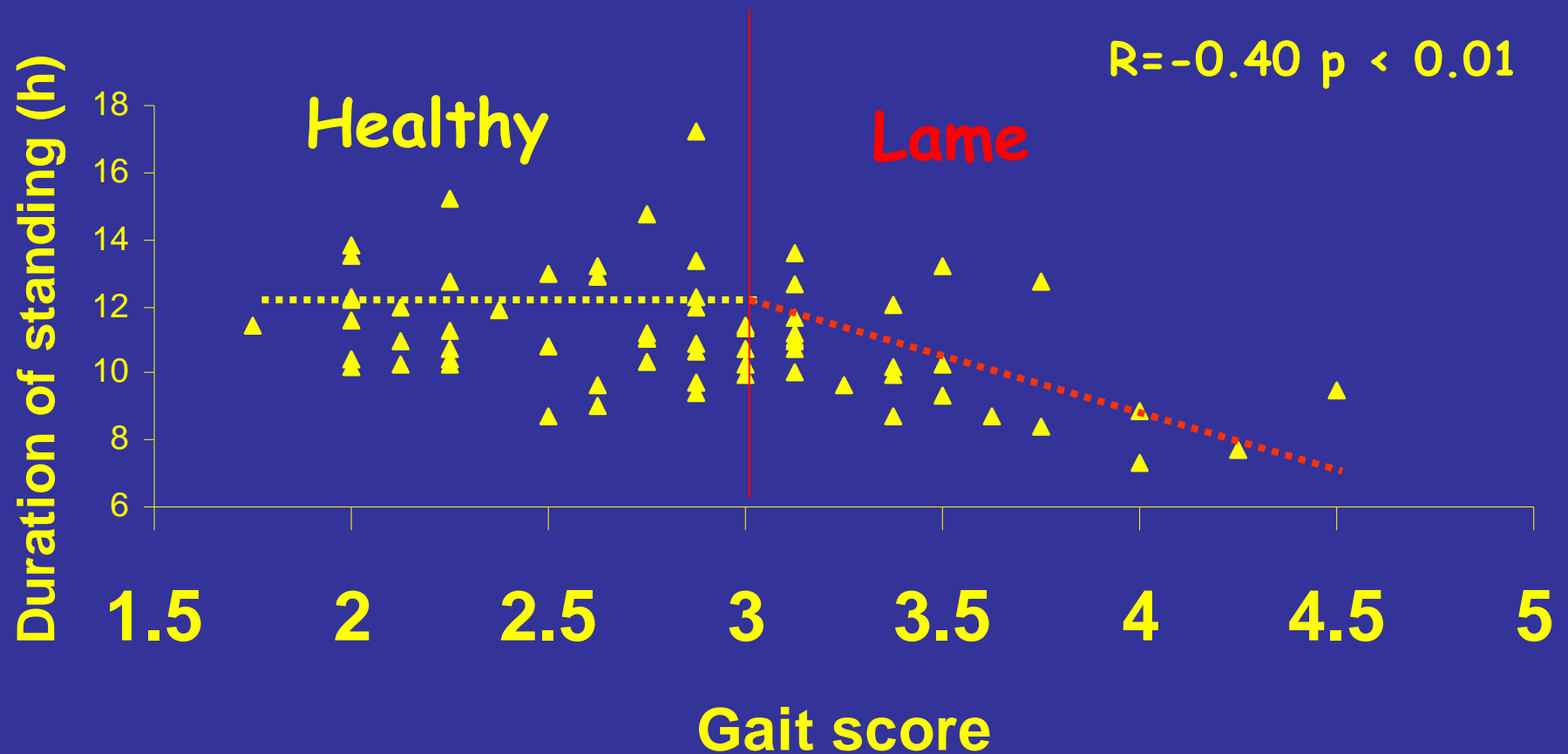


# Cows with ulcers spend less time standing up

Time spent standing up (minutes per day)

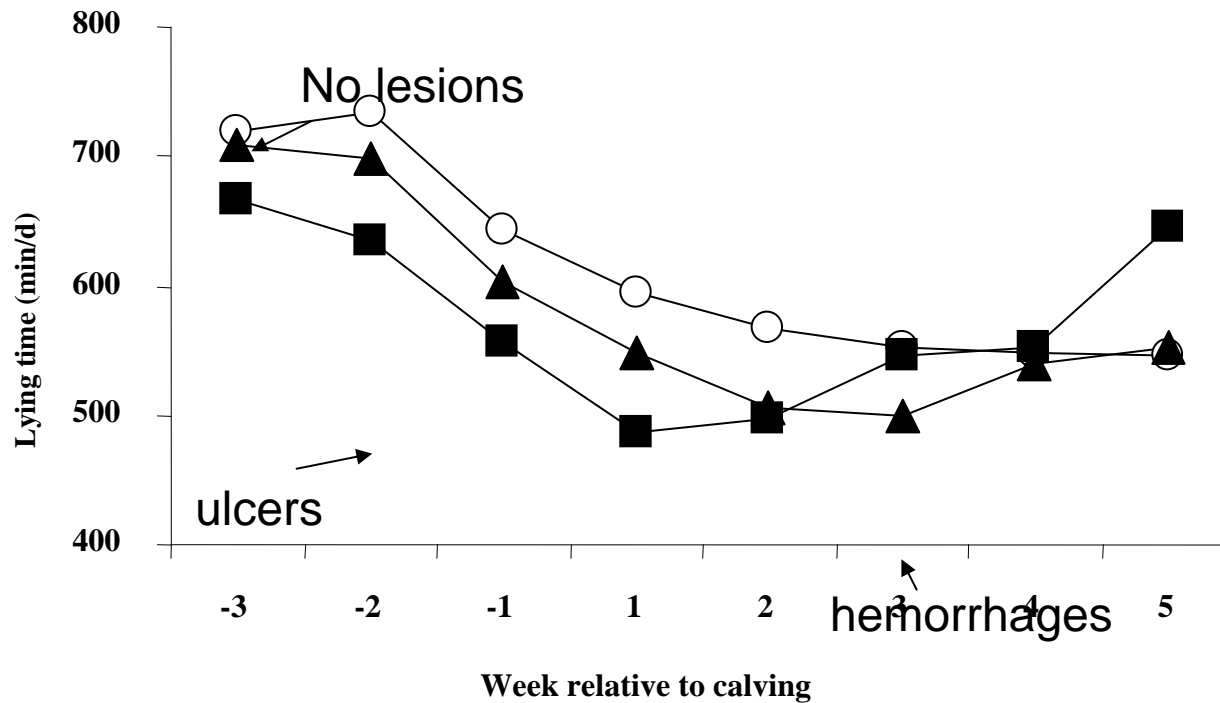


Lame cows spend more time lying down,  
but large variation between cows



# Cows that develop sole ulcers lie down for less time before calving but more time after calving

Chapinal JDS in press

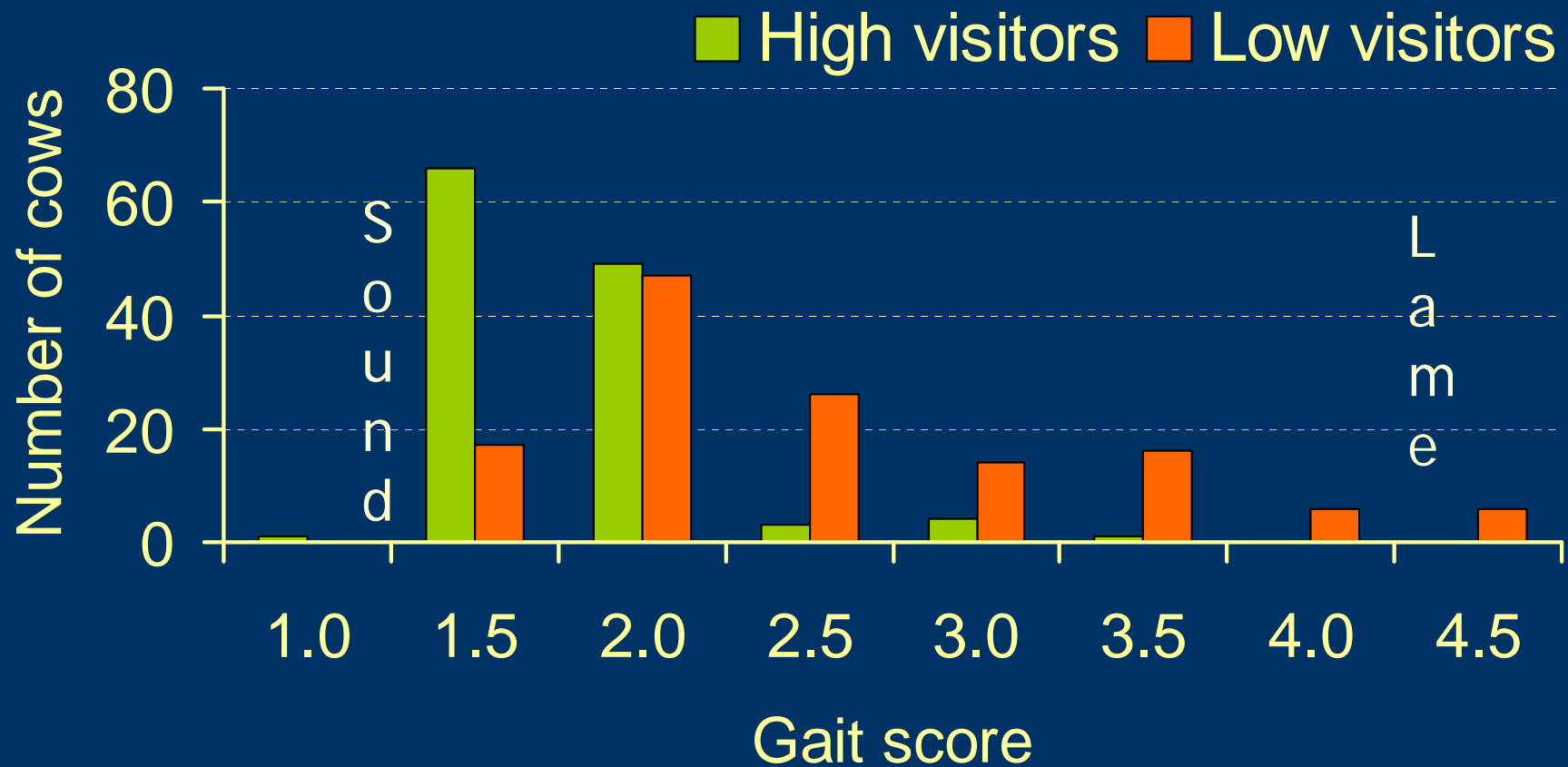


# Detection of lameness through frequency of visits to robotic milker



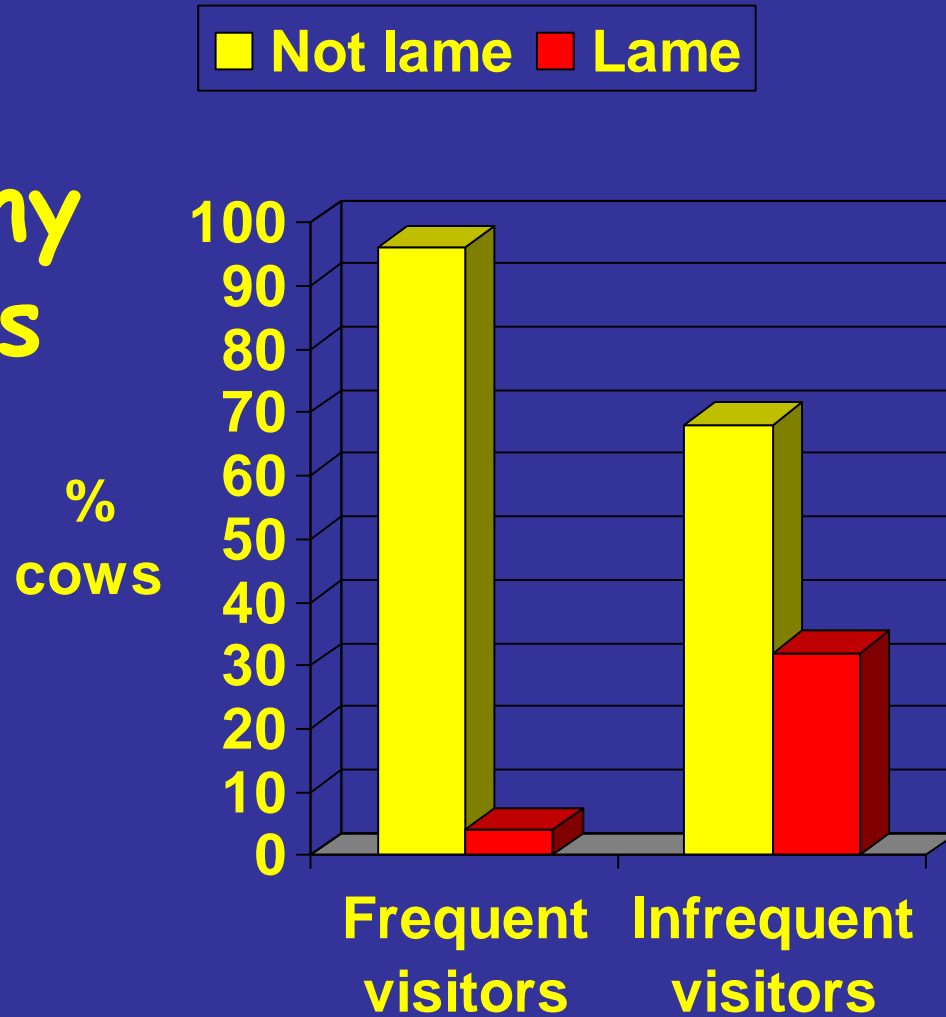
Borderas, T.F., A. Fournier, J. Rushen, and A.M.B. de Passillé. 2008. Effect of lameness on dairy cows' visits to automatic milking systems. *Can. J. Anim. Sci.* 88: 1-8

## Gait score of High and Low visitors to the milking robot



Borderas, T.F., A. Fournier, J. Rushen, and A.M.B. de Passillé. 2008. Effect of lameness on dairy cows' visits to automatic milking systems. *Can. J. Anim. Sci.* 88: 1-8

Few false  
negatives, many  
false positives



Borderas et al (2009) Can J Anim  
Sci

# Use of accelerometers to detect lameness

Hajime Tanida, Yuki Koba,  
Marie Toze, Idaku Ishii,  
Hiroshima University, Japan

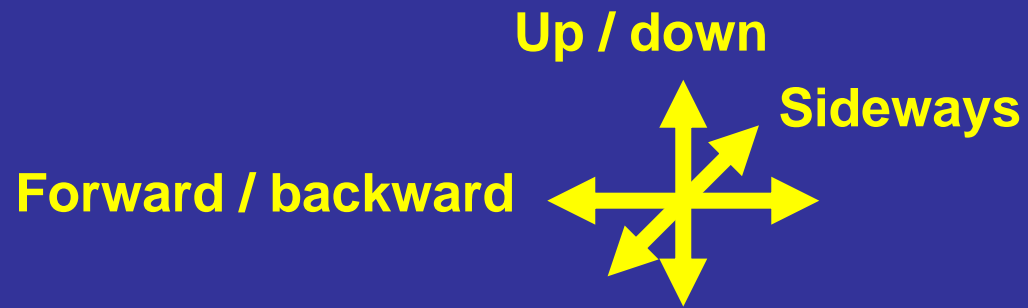
Lene Munksgaard, University  
of Aarhus, Denmark;

Nuria Chapinal, UBC



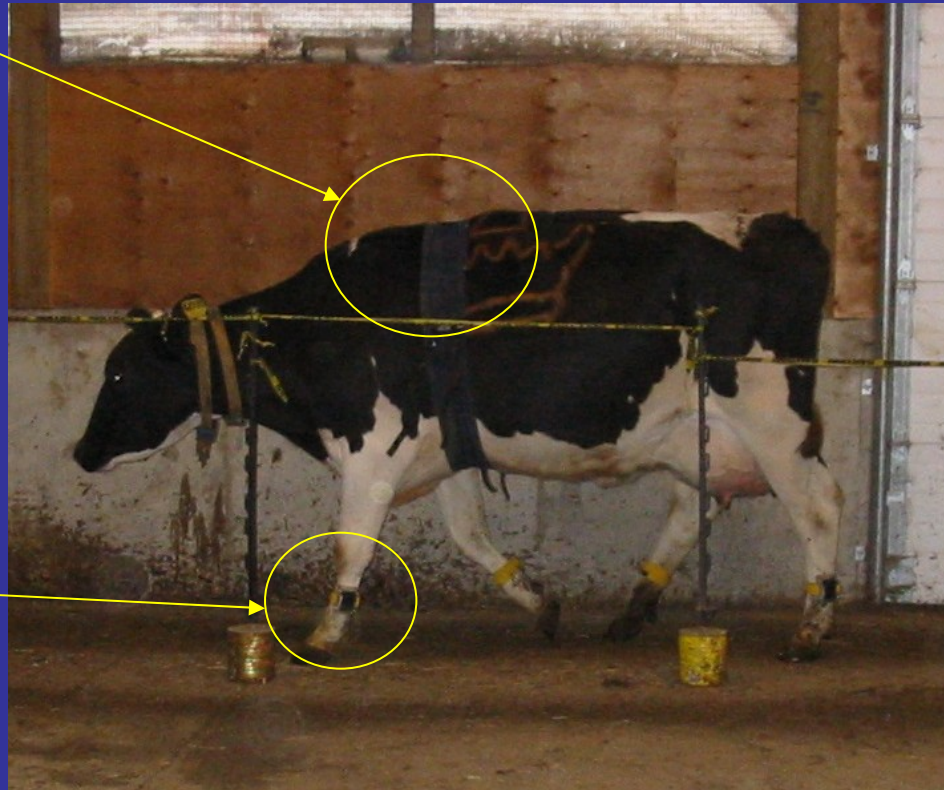
Accelerometers measure acceleration of various parts of the cow in 3- dimensions



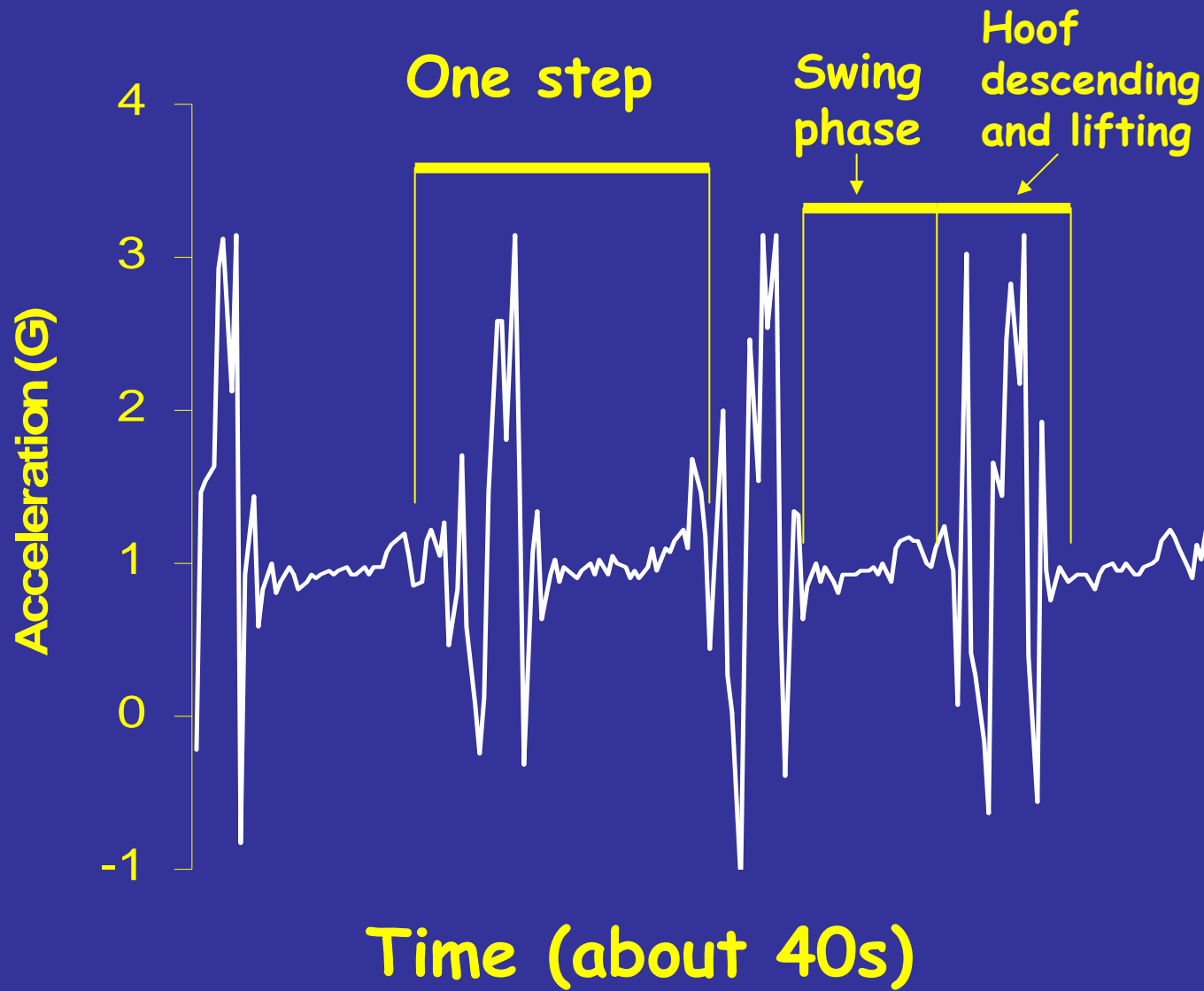


An accelerometer placed on the back measures overall acceleration of the cow in 3 dimensions

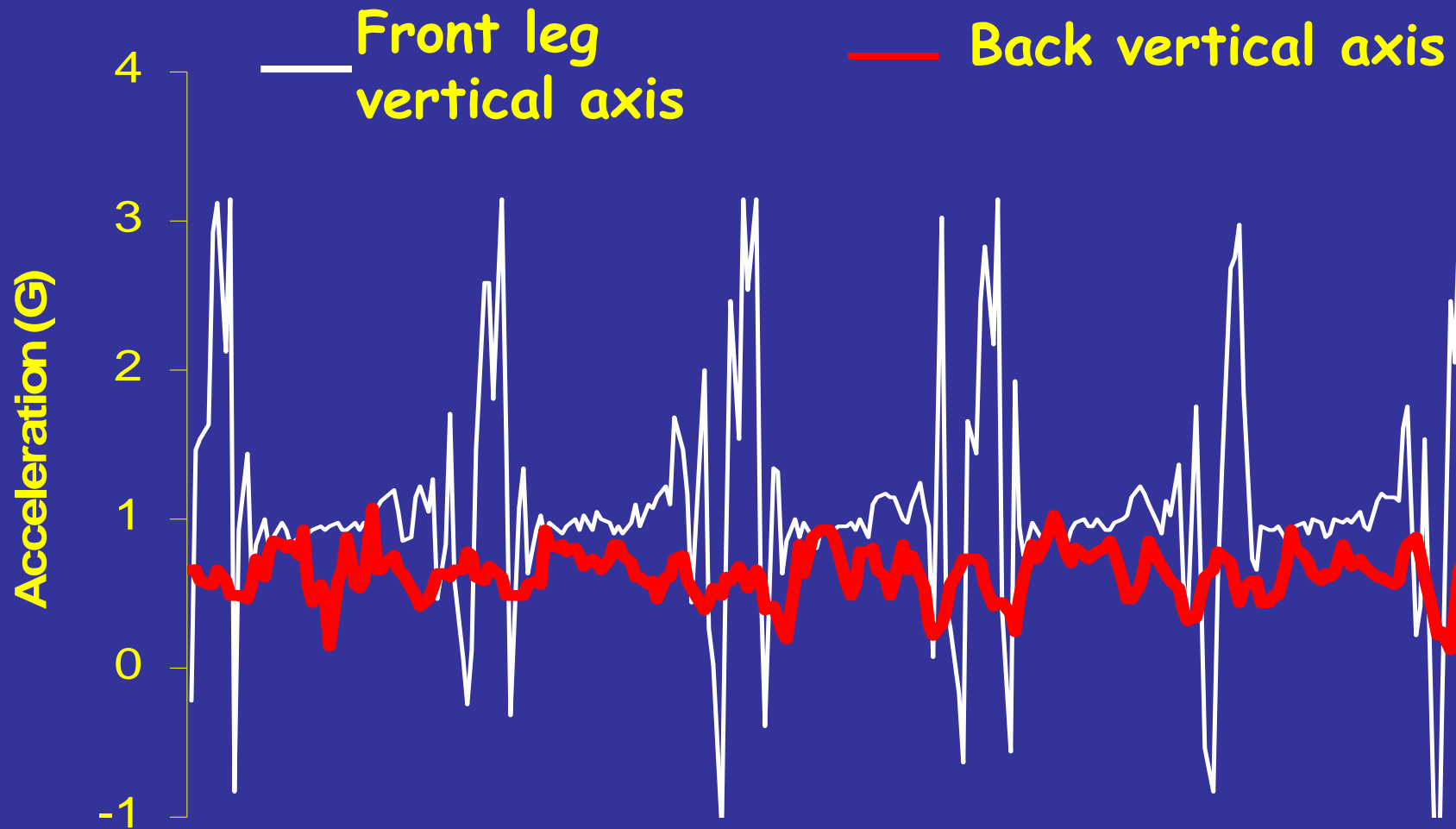
An accelerometer on the leg can identify steps and measure forces on the hoof during walking



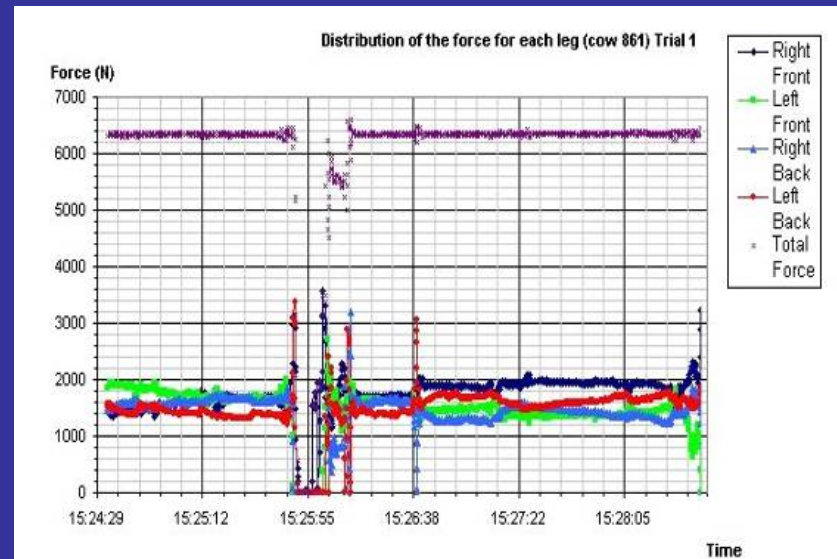
# Acceleration of front leg in vertical axis can identify steps



An acceleration on the back can measure acceleration of the whole cow



# Automated methods for detecting lameness through measures of weight distribution

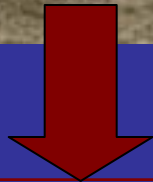


S. Neveux et al. 2006 J. Dairy Sci. 89:2503-2509

Rushen, J., et al. (2007) Applied Animal Behaviour Science 106, 173-177



45.3%



54.7%



# How cows distribute their weight

S. Neveux et al. 2006 J. Dairy Sci.  
89:2503-2509

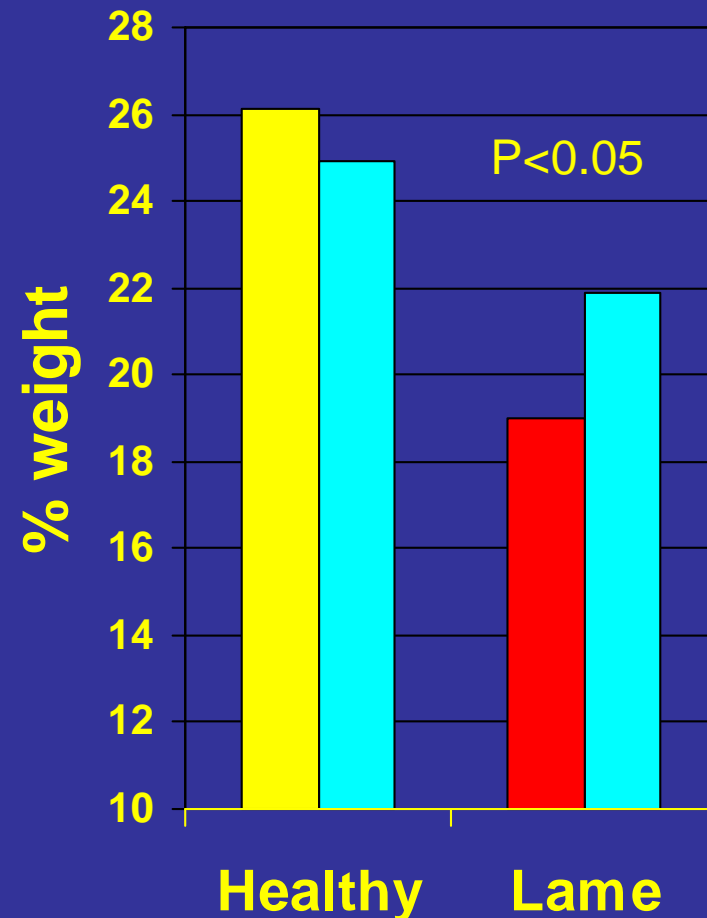
Weight removed  
from one hoof is  
redistributed to  
contralateral hoof

# Lame cows put less weight on injured leg than healthy cows After lidocaine, lame cows put more weight on injured leg

Rushen, J., et al. (2007) Applied Animal Behaviour Science 106, 173-177



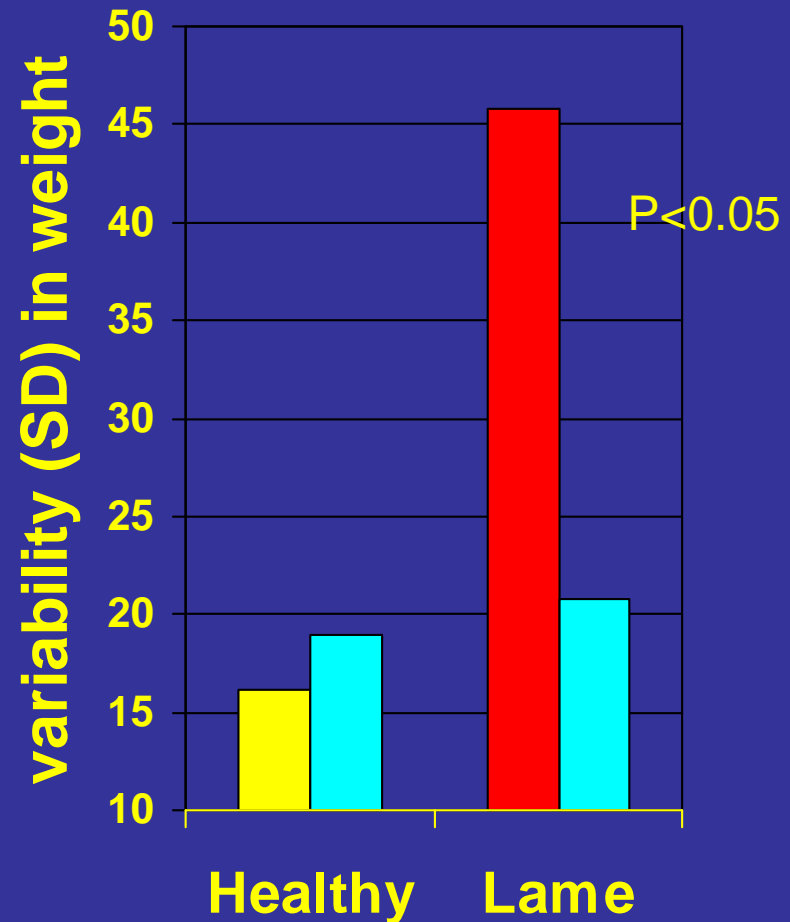
■ Before ■ Lidocaine



# Lame cows shift weight more between legs and this is reduced by lidocaine



■ Before ■ After lidocaine



Conclusion: New technology (automated milking systems, activity loggers, accelerometers, weight sensors) have great potential to improve our ability to gait detect lame cows

Use in animal welfare monitoring?