Improved detection of lameness

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Thanks: Dairy Farmers of Canada, NSERC, Animal Compassion Foundation.
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)
Lameness is one of the most serious and prevalent problems for farm animals selected for high growth rates or high milk production.

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.
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
Infectious causes of lameness

Dermatitis

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

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

- “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
Not lame | (lame) | severely lame

Combined to give an overall score

Head bob
Asymmetric steps
Reluctance to bear weight
Spinal arch
Tracking up
Swinging in/out
Joint flexion

Flower, F and Weary, D. M. JDS 2006 89: 139
Reliability (correlations) between and within-raters

<table>
<thead>
<tr>
<th></th>
<th>Intra-rater</th>
<th>Interrater</th>
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</thead>
<tbody>
<tr>
<td>Bear weight</td>
<td>.95</td>
<td>.79</td>
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<tr>
<td>Back Arch</td>
<td>.93</td>
<td>.77</td>
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<tr>
<td>Tracking</td>
<td>.92</td>
<td>.80</td>
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<tr>
<td>Asymm steps</td>
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<td>.72</td>
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<tr>
<td>Head bob</td>
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<td>.79</td>
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<tr>
<td>Joint flexion</td>
<td>.90</td>
<td>.58</td>
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<tr>
<td>Swing out</td>
<td>.68</td>
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</table>
Video- asymmetric stepping
reluctance to bear weight

Favoring one leg over another
Arched back

**Locomotion Score**

**Clinical Description:**

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

**Description:**

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

**Clinical Description:**

Arched back, but arches when walks. Gait is slightly abnormal.

**Description:**

Stands with flat back, but arches when walks. Makes long confident strides.

**Clinical Description:**

Normal.

**Description:**

Stands and walks normally with a level back.
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

Cows with no lesions

Cows with hoof lesions

Cut-off

Low Gait score High
What we get

“False negatives”

No lesions

“False positives”

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

Week relative to when sole lesion detected

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**

Score

<table>
<thead>
<tr>
<th>Component</th>
<th>No lesions</th>
<th>Hemorrhage</th>
<th>Ulcers</th>
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<tbody>
<tr>
<td>Bear weight</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Asym. Steps</td>
<td><strong>35</strong></td>
<td><strong>30</strong></td>
<td><strong>35</strong></td>
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<tr>
<td>Joint flexion</td>
<td><strong>30</strong></td>
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<td>Track</td>
<td><strong>25</strong></td>
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<td><strong>25</strong></td>
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<tr>
<td>Head bob</td>
<td><strong>20</strong></td>
<td><strong>15</strong></td>
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<td>Back</td>
<td><strong>25</strong></td>
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<tr>
<td>Leg swing</td>
<td><strong>15</strong></td>
<td><strong>10</strong></td>
<td><strong>15</strong></td>
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* Difference from cows with no lesions p<0.05
<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reluctance to bear weight</td>
<td>Characteristic of most cows with ulcers - easy to see</td>
</tr>
<tr>
<td>Asymmetric steps</td>
<td>Characteristic of most cows with ulcers - easy to see</td>
</tr>
<tr>
<td>Back arch</td>
<td>Extreme is characteristic of some cows with ulcers - easy to see</td>
</tr>
<tr>
<td>Head bob</td>
<td>Not very reliable - not a good sign of ulcers</td>
</tr>
<tr>
<td>Tracking</td>
<td>Affected by walking speed</td>
</tr>
<tr>
<td>Joint flexion</td>
<td>Not easy to see</td>
</tr>
<tr>
<td>Leg swing</td>
<td>Not a good sign of ulcers - affected by time since milking</td>
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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 4.36 km/h)
- With lower (8.8 cm vs 9.6 cm) and shorter (1.49 m vs 1.52 m) strides
- More time with three hooves on the ground at once (73.8% versus 69.7%)
- Worse ‘tracking up’

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

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

**Tracking up:** interaction type of cow X time p<0.05

**Back arch:** interaction type of cow X time p>0.10
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)

- No lesions
- Hemorrhages
- Ulcers
Lame cows spend more time lying down, but large variation between cows

\[ R = -0.40 \quad p < 0.01 \]
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

Gait score of High and Low visitors to the milking robot

Few false negatives, many false positives

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

One step

Swing phase

Hoof descending and lifting

Acceleration (G)

Time (about 40s)
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
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

45.3%  54.7%
Lame cows put less weight on injured leg than healthy cows. After lidocaine, lame cows put more weight on injured leg.

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

Variability (SD) in weight

Before

After lidocaine

P<0.05
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?