Occurrence, characterization and risk factors associated with lameness within Alberta feedlots


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Defining lameness in feedlot cattle

- Leg or foot problem that modifies an animal's gait (Greenough, 2007)

- Associated with
  - Pain
  - Reduced walking/standing
  - Rapid weight loss

- Causes?
  - Genetic
  - Metabolic/nutrition
  - Traumatic
  - Infectious
Importance to the beef industry

Animal care and social license
- Welfare conscious management

Economics
- Growth performance
- Drug and labor costs
- Market access
- Rejection at slaughter
What we currently know about lameness in feedlot cattle is limited

- 17% treated for lameness (Townsend et al., 1989)
- 16% treated for and 5% mortality related to lameness (Griffin et al., 1993)
- Incidence in chronic pens varied between 32.8 and 52.8% with an average of 37% and lame cattle treated less than for other pathologies (Tessitore et al., 2011)
- Incidence of lameness increased after processing 1.6 vs 2.5% (Green et al., 2012)
What we currently know about lameness in feedlot cattle is limited

- Increased days on feed (lame cattle required 2 wk longer to reach slaughter weight) (Tibbetts et al., 2006)

- Lame cattle gain more slowly than non-lame 1.75 lbs vs 2.95 lbs/d (Tessitore et al., 2011)

- Cost of foot rot ($33) and digital dermatitis ($56.18) USD for treatment in dairy cattle (Cha et al., 2010)

- Risk factors?
- Types of lameness?
Study Objectives

1. Determine occurrence of lameness in healthy and chronic pens by season and its relationship to other health problems

2. Characterize the types of lameness observed and their potential cause

3. Identify environmental or managerial factors associated with increased lameness
   - Health records study
   - Live animal study
**Health records study**

- 26 feedlots (> 8000 hd) over 8 yr period (2005-2013) representing 445,876 cattle

**Animal and health factors**
- Age (DOB)
- Sex (M/F)
- Breed
- Source (ranch, auction, feedlot)
- Weight (real or estimated at receiving)
- Distance transported
- Vaccination and implant information
- Diagnosis/treatments
- Number of day in chronic pen

**Feedlot management factors**
- Diets composition
- Days on feed (DOF)
- Frequency and timing of feeding
- Pen number
- Group size
- Bunk and pen space allowance
- Location of water
- Feed additives ie Beta-agonist
- Weather
- Pen condition
Health records study (outcomes)

• Total # of cattle in healthy and chronic pens treated for lameness and when they occur according to DOF and month/season

• Occurrence of specific lameness (footrot, joint infection, arthritis, injury, etc.)

• Frequency of treatments (relapses)

• Association between variables listed under animal, feedlot management and environmental factors and lameness (type)

• Economic costs associated with lameness including drug, animal loss (weight and mortality and labor)
Live animal and post mortem study

- 2 feedlots (>10,000 hd) weekly over 2 yr period

- Acutely Lame
  - Cattle pulled for lameness for the first time in healthy pens
  - Compare with non-lame population in same pen

- Chonically lame
  - Cattle previously pulled as acutely lame within chronic pen
  - Compare with non-lame population

- Post Mortem (PM)
  - Necropsy of euthanized/deceased lame cattle
  - Assess joints (stifle, hip, hock and fetlock, elbow and coffin only if swollen)
  - Assess for lung and liver abscesses
**Behavioral measurements (gait score; severity)**

**Lameness Score 1-5:**

1. **Sound**
   
2. **Mild Lameness**
   Stands with flat back, but arches when walks. Gait is slightly abnormal.

3. **Moderate Lameness**
   Stands and walks with arched back. Moves with short strides; reduced weight bearing can be detected on affected leg. Head drops when weight is taken on affected leg.

4. **Severe Lameness**
   Back arched when standing and walking, obvious reduced weight bearing on affected limb. Cow moves slowly, often making frequent stops, and may show secondary signs of pain such as weight loss, teeth grinding and excess salivation.

5. **Severe Lameness**
   Back arched, unable to move. Does not take weight on the affected leg.

**Lameness Score 0-3:**

0. **Normal**

1. **Mild Lameness**
   Animal exhibits shortened stride, No limp or head bob.

2. **Moderate Lameness**
   Animal exhibits obvious limp, arched back. Head bob present when walking

3. **Severe Lameness**
   Animal applies little or no weight to affected limb
   Animal reluctant or unable to move
   While standing, head will be low and back arched
   While walking head is dropped, back arched, head bob and limp.
Lameness severity based on gait score

5 point score

1- Sound
2- Mild
3- Moderate
4- Severe
5- Highly Severe
Animal and health factor measurements

Animal Feedlot tag number/color
________________________________________________________________________________________ Sample #:
________________________________________________________________________________________

Assigned tag #_________________________ Pen # (from)______________________________
Destination Pen (to): ________________________________
Weight ______________kg      Breed: _____________Sex:    Bull     Steer   Heifer  Cow
Body Score:    1     2     3     4      5                  Rectal Temp ____________ -
_________________°C/°F

Left Fore

Right Fore

Left Hind

Right Hind
Physiological measurements

- Substance P (neuropeptide biomarker of pain)
- Immune Function
  - WBC, neutrophil: lymphocyte
  - Acute phase proteins (haptoglobin)
- Cortisol (saliva, hair)
Physiological measurements

- Infrared thermography (Inflammation)

Body temperature
Health records
Tag score

Mader and Colgan (2007):

1. small lumps of mud on the hide in limited areas of the leg and underbelly

2. small and large lumps of mud covering larger areas of the legs, side, and underbelly

3. small and large lumps of mud evenly covering the hide on the hind quarter, stomach and front shoulder

4. lumps of mud continuously covering the underbelly and side of the animal from the brisket to rear quarter.
Pen condition
What we know after 3 years of studying lameness

- Incidence of lameness 5.89 %/yr vs. 9.44 % of respiratory disease
- Lameness represented 30.38 % of all treated animals/year (vs. 46.78 %)
- Relapse rates were 8.07 %
- Interval between pulls (relapse) was 25 ± 36.7 d.
- 7.76 % of the euthanized cattle was due to lameness

LAMENESS IS AN IMPORTANT HEALTH AND WELFARE ISSUE
What we know

- Lameness treatment varied between $8.40 and $42.20
- With each additional pull (relapse) the cost increases by $3.5
- Production loss was estimated at $81.40/animal

LAMENESS IS AN IMPORTANT ECONOMIC ISSUE
Types of Lameness

- Swollen joint / joint infection 4.7%
- Injury 4.7%
- Laminitis 0.33%
- P3 necrosis 3.9%
- Foot rot 45.7%
- Digital dermatitis 23.2%
- Lame no-swelling 4.9%
- Problems proximal limb 5.8%
- Affected by 2 types of lameness 4.9%
Foot Rot
Digital Dermatitis
P3 necrosis
What can we do?

Correlation between cowboy diagnosis at pull and diagnosis of research staff (behavior, physiology, health records)
Was only 33% over 1122 animals
Poor agreement
To improve diagnosis you must look!
Strategies to reduce lameness

Handling

Every time handled (reimplanting) severe lameness increased by 38 %
Strategies to reduce lameness

Pen condition and season

Mud depth > 5 cm 2 x more likely to be lame

Infectious lameness 2 times more likely in spring

Mechanical lameness > in fall and winter
Strategies to reduce lameness

Origin/Type of cattle

Winter placed calves and yearlings were 2 and 6 times more likely to be lame than Holsteins
Strategies to reduce lameness

**Pen Density/bunk**
Decrease 1.5 % for every 1 m increase in bunk space

**Diet**
Decrease 0.8 % for every 1 % increase in forage
Live Animal Results

- **Immune function**
  - P3 cattle had greater ($P < 0.05$) platelet and lypmocyte counts than cattle with footrot or injury.
  - DD cattle had greater ($P < 0.05$) WBC counts than cattle diagnosed with P3 necrosis.
  - DD cattle had lower granulocyte ($P < 0.05$) numbers than all other lesions in the claws.

- **Substance P**
  - Swollen joints and problems in the proximal limbs had greater ($P < 0.01$) concentrations of substance P, followed by footrot.
  - Cattle with an injury diagnosis had the lowest ($P < 0.05$) concentrations of substance P compared to all other diagnoses.

- **Salivary Cortisol – No difference**
Live Animal results

- **Gait score**
  - Lameness associated with proximal limbs (swollen hip, stifle, fetlock and hock) had higher ($P < 0.05$) gait scores than those only with claw lesions

- **Rectal Temp**
  - P3 > RT than all other types
  - DD < RT than all other types

- **Body weight and BCS**
  - Lame cattle 49 +/- 10.2 kg lighter than non-lame
  - BCS 2 units lower
**Decision Tree - new protocols**

**Foot Rot**
- **Gait Score 2**
  - Swelling
    - Open Lesion
  - No swelling
    - Closed Lesion
- **Gait Score 3**
  - Swelling
    - Open Lesion
    - Closed Lesion
  - No swelling
- **Gait Score 4**
  - Swelling
    - Open Lesion
    - Closed Lesion
  - No swelling
- **Gait Score 5**

**Case 1** – GS 2
- Swelling: Yes
- Open Lesion
- SP: 48.8
- Hp: 0.87
- Cort: 6.7

**Case 2** – GS 2
- No swelling: Yes
- Closed Lesion
- SP: 77.3
- Hp: 3.35
- Cort: 18.6

**Case 3** – GS 3
- Swelling: Yes
- Closed Lesion
- SP: 71.8
- Hp: 5.5
- Cort: 26.5

**Case 4** – GS 3
- Swelling: Yes
- Open Lesion
- SP: 94.8
- Hp: 8.3
- Cort: 29.2

**Improve mitigation strategies**
- 1 d Treat
  - Return to home pen
- 3-5 d Treat
  - Return to home pen
- No recovery
  - Send to Hospital pen
  - Ship for emergency slaughter or euthanize
  - ? Weeks
  - Improve mitigation strategies
Conclusions

- Lameness is a significant health and welfare issue in feedlot cattle

- Aid industry in developing strategies for the mitigation of lameness and further testing

- Improve how producers manage lame animals by identifying and reducing risk factors

- Develop science-based recommendations for best management practices to manage lameness
Relationship between biomarkers of stress, inflammation and pain and lameness in feelot cattle

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Introduction

30% of all treatments
Introduction

- In dairy lame cattle:
  - Lameness increase WBC and N:L ratio (Meimandi Parizi and Khalafizadeh, 2006)
  - Dairy cows with sole ulcer increase serum cortisol and haptoglobin (O’Driscoll et al. 2015)
  - Lame dairy cattle had greater concentration of SAA, haptoglobin, fibrinogen and CRP (Bagga et al. 2016)

Lack of information in feedlot cattle
Objectives

1. Characterize biomarkers of stress, inflammation and pain in lame and non-lame feedlot cattle
2. Evaluate the relationship between biomarkers of stress, pain and inflammation and lameness severity in feedlot cattle
3. Determine if the biomarkers concentration can help to differentiate lameness diagnoses
Material and Methods

- Over two-year period 1305 calves were evaluated:
  - 1207 lame and 98 non-lame (pulled from the same pen)
    - Gait scored (0: non-lame; 4: severely lame)
    - Rectal temperature
    - Saliva samples for salivary cortisol
    - Hair samples for hair cortisol
    - Blood samples for acute phase proteins, substance P and blood cell count.
Material and Methods

- Legs of the lame calves were lifted to diagnose type of lameness:
  - Foot rot
  - Digital dermatitis
  - Joint infection
  - P3 necrosis
  - Injury
- Characteristics of the lesions:
  - Open/closed
  - Swelling / No swelling
Results

Evaluate biomarkers of stress, inflammation and pain in lame and non-lame cattle
Results

- Cortisol concentrations increase in response to handling in cattle (Mormède et al., 2007).

- Lack of differences in hair cortisol: 1) animals might not have been lame for a long enough period of time to deposit cortisol in high enough concentrations to be differentiated or 2) that other clinical and subclinical diseases or stressors might mask the deposition of cortisol in the hair attributable to lameness.
DeVane (2001) described that substance P is a known modulator of nociception involved in signalling the intensity of noxious or adverse stimuli.
Results

Acute phase proteins used as indicators of infection, inflammation, surgical trauma and stress in cattle (Murata et al., 2004; Horadagoda et al., 1999)

Lameness diagnoses such as foot rot, digital dermatitis, injuries and swollen joints cause infections and inflammation (Greenough (1997)
Results

Hematocrit 0.24-0.46 L/L
Hemoglobin 80-150 g/L
RBC 0.5-1×10^12/L
Platelet count 100-800×10^9/L
Results

**WHITE BLOOD CELLS**

- WBC 4–12 $10^9$ /L
- N:L < 1

**N:L RATIO**

- NL □ L

*P < 0.001*
Results

Evaluate the relationship between biomarkers of stress, pain and inflammation and lameness severity in feedlot cattle.
Results

Table. Logistic regression model for relationship between additional biomarkers of stress/pain in the characterization of lameness severity.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-2.1665</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Substance P</td>
<td>-0.000685</td>
<td>0.993</td>
<td>0.985-1.001</td>
<td>0.09</td>
</tr>
<tr>
<td>Haptoglobin</td>
<td>0.2602</td>
<td>0.3602</td>
<td>1.287-1.597</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

- Cattle with severe lameness had haptoglobin concentrations that were 43 % greater than in cattle that had mild to moderate lameness.

- Mean haptoglobin concentrations of 2.8 ± 2.35 g/L (mean ± SD) while mild to moderately lame cattle had mean concentrations of 1.4 ± 1.66 g/L (mean ± SD).
Results

Determine if the biomarkers concentration can help to differentiate lameness diagnoses
Results
Conclusion

- Biomarkers of stress as salivary cortisol and hair cortisol, and rectal temperature were not able to discriminate between lame and non-lame cattle.
- Haptoglobin, SAA and WBC were useful indicators of lameness in feedlot cattle.
- Haptoglobin was the only biomarker that differentiate lameness severity.
- Biomarkers of stress, pain and inflammation can be use as a tool to help on lameness diagnosis.
Acknowledgements