Epidemiology of subclinical ketosis in early lactation dairy cattle

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Negative Energy Balance (NEB)

• Dairy cows enter a state of NEB during the transition period

• Increased energy demand in early lactation

• Inability to adapt:
  - Metabolic disorders
  - Infectious disease
  - Decreased milk production
Adaptation to NEB

- Mobilization of fat
- Production of non-esterified fatty acids (NEFA)
- Elevation of blood ketone bodies
Ketosis

• Ketosis is the elevation of ketone bodies:
  - Acetone
  - Acetoacetic acid
  - $\delta$-hydroxybutyric acid (BHBA)

• Clinical manifestation:
  - Decrease in appetite
  - Weight loss
  - Decrease in milk production

• Subclinical ketosis
Subclinical Ketosis

• Increased risk of displaced abomasa and metritis
  - Duffield et al., 2009; Ospina et al., 2010

• Decrease milk yield in early lactation
  - Dohoo and Martin, 1984; Ospina et al., 2010

• Lactation incidence widely variable ~40%
  - Compared to 2 to 15% found with clinical ketosis
Purpose of Observational Study

• Describe the epidemiology of SCK
• Time of onset
• BHBA concentration at onset

- Displaced abomasum (DA)
- Removal from herd
- Reproduction
- Milk yield
Precision Xtra® Ketone System

- Requires 1.5 µl of whole blood
- Result in 10 seconds
- 1€ per test

- Compared to serum BHBA
  - Sensitivity: 88 – 96%
  - Specificity: 96 – 98%
  - Iwersen et al., 2009; Konkol et al., AABP 2009
Study Herds

• Two free-stall dairies in NY
  - Farm A: 41.8 kg milk (1900 cows)
  - Farm B: 41.8 kg milk (1825 cows)

• Two free-stall dairies in WI
  - Farm C: 39.1 kg milk (2800 cows)
  - Farm D: 35.0 kg milk (4100 cows)
Study Design

• Data collected from May - August, 2010

• Cows tested 6 times between 3 – 16 DIM
  – M, W, F testing

• Subclinical ketosis 1.2 – 2.9 mmol/L
Statistical Analysis

- Poisson regression
  - DA
  - Removal from herd
  - Conception to 1st service

- Semiparametric proportional hazards model
  - Median time to resolution

- Repeated measures ANOVA
  - Milk weights
Cow Enrollment

• 2115 cows enrolled
  - Removed from analysis
    • Gestation length < 260 d
    • Died/sold
    • Farm ketosis treatment
    • Improper identification
    • Fewer than 5 tests

• 1717 cows in final analysis
  - 976 non-ketotic cows
  - 741 ketotic cows
## Subclinical Ketosis Incidence

<table>
<thead>
<tr>
<th>Herd</th>
<th>Location</th>
<th>Cows</th>
<th>SCK (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>NY</td>
<td>354</td>
<td>40.4</td>
</tr>
<tr>
<td>B</td>
<td>NY</td>
<td>402</td>
<td>26.4</td>
</tr>
<tr>
<td>C</td>
<td>WI</td>
<td>291</td>
<td>40.9</td>
</tr>
<tr>
<td>D</td>
<td>WI</td>
<td>670</td>
<td>55.7</td>
</tr>
<tr>
<td>All</td>
<td>---</td>
<td>1717</td>
<td>43.2</td>
</tr>
</tbody>
</table>
Incidence of SCK by DIM

First SCK Positive BHBA Test (%)

Days in Milk

3 4 5 6 7 8 9 10 11 12 13 14 15 16
Prevalence of SCK by DIM

Days in Milk

SCK Positive BHBA Test (%)
Median Time to Resolution

![Graph showing the relationship between time to one negative BHBA test and the percentage of cows with SCK.](image-url)
Association of DIM at Onset

- Compared cows first SCK positive from 3 to 7 DIM with cows first positive from 8 to 16 DIM
Association of DIM at Onset

- Compared cows first SCK positive from 3 to 7 DIM with cows first positive from 8 to 16 DIM

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Response</th>
<th>95% CI(^1)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA(^2)</td>
<td>RR(^3) = 6.1</td>
<td>2.3 to 16.0</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

\(^{1}\) CI = Confidence interval  
\(^{2}\) DA outcome tested between cows first positive from 3 to 5 DIM versus 6 to 16 DIM  
\(^{3}\) RR = Risk ratio
Association of BHBA at Onset

• Each 0.1 mmol/L increase in BHBA concentration:
  - e.g. 1.2 mmol/L vs. 2.4 mmol/L:
    • 3.1 times more likely to develop a DA (1.1^{12})
    • 56.7 times more likely to be removed from the herd (1.4^{12})
  - No difference in conception to 1^{st} service

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Risk Ratio</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA</td>
<td>1.1</td>
<td>1.0 to 1.2</td>
<td>0.002</td>
</tr>
<tr>
<td>Early removal</td>
<td>1.4</td>
<td>1.1 to 1.8</td>
<td>0.01</td>
</tr>
</tbody>
</table>
Association of BHBA at Onset

• Each 0.1 mmol/L increase in BHBA concentration:
  - Associated with a 0.5 kg per day decrease in milk
    \((P < 0.001)\)
Conclusions

1) SCK occurs early in lactation!

2) Cows that develop SCK within 7 DIM are at a much higher risk for adverse events.

3) This risk increases as the BHBA concentration at first positive test increases.
Acknowledgements

- Cornell vet students
- Wisconsin vet students
- Study herds

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