Managing the Transition Cow-Emphasis on Ketosis and Fatty Liver Syndrome

Ric R. Grummer
Ruminant Technical Manager
Balchem Corp., New Hampton, NY
&
Emeritus Professor
Department of Dairy Science
University of Wisconsin-Madison
Topics

• Introduction
• Etiology of Fatty Liver and Ketosis
• Strategies for Prevention
• Management of Fatty Liver and Ketosis Through Basal Diet
• Management of Fatty Liver and Ketosis through Feed Additives
### Are Things Getting Any Better?

<table>
<thead>
<tr>
<th></th>
<th>USDA NAHMS</th>
<th>Butler, 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinical Mastitis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>13.4 %</td>
<td>1975</td>
</tr>
<tr>
<td>2007</td>
<td>16.5%</td>
<td>2001</td>
</tr>
<tr>
<td><strong>1st Service Conc. Rate</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55%</td>
<td></td>
<td>39%</td>
</tr>
<tr>
<td><strong>Ketosis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Since the late 1990's ketosis has emerged as the most important metabolic disease in dairy herds in the US, surpassing ruminal acidosis and milk fever in clinical significance&quot;</td>
<td>Oetzel, 2007</td>
<td></td>
</tr>
</tbody>
</table>
Hoard’s Dairyman Survey - Ketosis

% of herds with problem

Year

1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009

BALCHEN
ANIMAL NUTRITION & HEALTH

Protection
nutrition
# The Record Cow

**Ever-Green-View My 1326 ET**  
Waldo, WI  
3x/365 days

<table>
<thead>
<tr>
<th></th>
<th>365 d</th>
<th>Ave/d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk, lb</td>
<td>72,169</td>
<td>185.9</td>
</tr>
<tr>
<td>Prot, lb</td>
<td>2786</td>
<td>7.5</td>
</tr>
<tr>
<td>Fat, lb</td>
<td>2141</td>
<td>5.95</td>
</tr>
<tr>
<td>Calf req, lb milk/d for 42 d</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
Dry Matter Intake and Plasma NEFA

![Graph showing Dry Matter Intake (DMI) and Plasma NEFA levels over days relative to calving. The graph includes points for NEFA and DMI with varying values over time.]

Grummer, 1993
Liver Triglyceride

Liver TG
% DM basis

Day relative to calving

Vazquez-Anon et al., 1994
Transition Cow Lipid Metabolism

Adipose

Mobilized Fat

TAG
Fatty Acid
Glycerol

VLDL

Negative EB
Hormonal changes at calving

Liver

Oxid

AcCoA

CO₂

NEFA

NEFA

TAG

VLDDL

Stored TAG

Ketone
Can We Manage Energy Related Disorders-- Fatty Liver and Ketosis-- via Dry Cow Diets?
<table>
<thead>
<tr>
<th>Trial</th>
<th>NFC, % DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor et al., 1998</td>
<td>35, 44</td>
</tr>
<tr>
<td>Mashek and Beede, 2000</td>
<td>35, 38</td>
</tr>
<tr>
<td>Keady et al., 2001</td>
<td>13, 28</td>
</tr>
<tr>
<td>Holcomb et al., 2001</td>
<td>25, 30</td>
</tr>
<tr>
<td>Doepel et al., 2001</td>
<td>24, 30</td>
</tr>
<tr>
<td>Rabelo et al., 2003, 05</td>
<td>38, 45</td>
</tr>
<tr>
<td>Smith et al., 2005</td>
<td>34, 40</td>
</tr>
<tr>
<td>Kamiya et al., 2006</td>
<td>28, 33</td>
</tr>
</tbody>
</table>
Summary of Results

• 5/7 Studies showed a significant increase in prepartum DMI.

• 0/6 Studies showed any significant effect on postpartum DMI.

• 0/7 Studies showed any significant effect on milk yield.

• 1/5 Studies showed a significant reduction in liver fat.
Pre-fresh NFC??

• If increasing prepartum concentrate (NFC) feeding does not affect milk yield or DMI, energy balance will not be affected.

• If energy balance is not affected, metabolic health and reproductive performance will probably not be affected.
The Transition Cow Index uses fourteen factors from the historical DHIA record of each individual cow to project her milk yield. Deviations from her expected milk yield are calculated and used at the herd level to evaluate the overall effectiveness of transition cow management programs.
Prefresh ration NDF %

y = -3.605x - 611.8
R² = 6E-05

Herd Average TCI

NDF, % DM

Courtesy of Ken Nordlund
Other 3 wk Pre-fresh Studies

• Substituting non-forage NDF for forage NDF (3 studies)
  – Milk: 0/3
  – Feed intake: 0/3
  – NEFA or fatty liver: 0/2
  – BHBA: 1/2 (decreased 1.2 mg.dL)

• Ad libitum vs restricted energy (3 studies)
  – Milk: 0/3
  – Feed intake: 0/3
  – NEFA: 0/3
  – BHBA or fatty liver: 0/1
What about the entire dry period?

High forage diets?

Energy limitation?
## Energy Limitation the Entire Dry Period (Overfed vs ~80-100% of Maintenance)

<table>
<thead>
<tr>
<th>Study</th>
<th>Duration</th>
<th>Method</th>
<th>DMI, lb/d</th>
<th>Milk or ECM, lb/d</th>
<th>NEFA, mEq/L</th>
<th>BHBA, mg/dl</th>
<th>Liver TG, % wet wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grum 1996</td>
<td>56 d</td>
<td>F:C</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Agenas/Holtenius 2003</td>
<td>64 d</td>
<td>FR</td>
<td>NS</td>
<td>NS</td>
<td>-.15</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Douglas 2006</td>
<td>60 d</td>
<td>FR</td>
<td>+4.6</td>
<td>NS</td>
<td>-.10</td>
<td>-1.2</td>
<td>-2.6</td>
</tr>
<tr>
<td>Winkelman 2008</td>
<td>45 d</td>
<td>FR</td>
<td>NS</td>
<td>NS</td>
<td>-.14</td>
<td>-0.7</td>
<td>NS</td>
</tr>
<tr>
<td>Neilsen 2009</td>
<td>100 d</td>
<td>F:C&amp;F</td>
<td>NS</td>
<td>NS</td>
<td>-.11</td>
<td>+0.9</td>
<td>NS</td>
</tr>
<tr>
<td>Keogh 2009</td>
<td>70 d</td>
<td>FR</td>
<td>NS</td>
<td>-4.8</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Janovic k 2010</td>
<td>65d</td>
<td>F:C or FR</td>
<td>NS</td>
<td>NS (-20.5)</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
</tbody>
</table>

**Cut off for significance, P < .10**
Energy Limitation the Entire Dry Period
(Overfed vs ~80-100% of Maintenance; 6 studies from 1996 to 2010)

• ↑ Feed intake: 1/6 (4.6 lb increase)
• ↑ Milk (or ECM): 0/7
• ↓ NEFA: 5/6 (.10-.15 mEq/L decrease)
• ↓ BHBA: 3/6 (.7-1.2 mg/dL decrease)
• Liver TG: 2/4 (-2.6% unit decrease)
Conclusions: Dry Cow Feeding

- Lots of flexibility in what we feed during the final 3 wks before calving.
- Overfeeding feeding during the entire dry period may have modest negative effects on plasma NEFA, BHBA and liver TG; however, lactation performance does not seem to be affected.
- Dry cow feeding may offer limited potential to alter postpartum health and production
Management of Fatty Liver and Ketosis via Feed Additives?
Additives to Prevent Fatty Liver/Ketosis

1. Block mobilization of fat from adipose tissue
2. Increase fat (VLDL) transport out of the liver

Additives

- Negative EB
- Hormonal changes at calving
Choline

- Referred to as a vitamin, but it is not
  - Can be synthesized endogenously
  - Not an enzyme cofactor
  - Supplemented in large quantities

- Proven as essential nutrient for many species

- Classic deficiency symptom: fatty liver
Functions of Choline

• One carbon (methyl) metabolism
  – Spare methionine

• Constituent of phospholipid
  – Phosphatidlycholine
    • Membrane
    • Lipoproteins (blood lipid transport)

• Acetylcholine (neurotransmitter)
Choline
Dr. R. Erdman (1992)

• Is choline a limiting nutrient for ruminant animals?
• Feed intake: 30 g/d
• Escaping ruminal breakdown: 1 g/d
• Ruminal production: 0 g/d
• Supply to intestine: 1 g/d
• Excreted in milk: 5 g/d
• Potential requirement: 30 to 50 g/d
Is there a role for supplemental choline in prevention of fatty liver??

• Cornell research showed that RPC reduced liver TG in transition cows, but NS (P < .18)

• UW research showed that RPC prevented and alleviated fatty liver in feed restricted dry cows
RPC: Reduced TAG at wk 1 ($P = .04$) and 3 ($P = .12$)
Effect of RPC (-3 wk to 80 DIM) on Subclinical Ketosis
Lima et al., 2007

Treatment: $P = 0.07$

TRT*Parity: $P = 0.05$

<table>
<thead>
<tr>
<th>Day Postpartum</th>
<th>Primiparous</th>
<th>Mutiparous</th>
<th>Primiparous</th>
<th>Multiparous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>Control</td>
<td>RPC</td>
<td>Control</td>
<td>RPC</td>
</tr>
<tr>
<td>Day 14</td>
<td>Control</td>
<td>RPC</td>
<td>Control</td>
<td>RPC</td>
</tr>
</tbody>
</table>

BALCHEM
ANIMAL NUTRITION & HEALTH

protection nutrition™
Effect of RPC on Ketosis - All Cows

<table>
<thead>
<tr>
<th>Condition</th>
<th>Control</th>
<th>RPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical Ketosis</td>
<td>11.2</td>
<td>4</td>
</tr>
<tr>
<td>Relapse</td>
<td>6.8</td>
<td>2.3</td>
</tr>
<tr>
<td>Sub clin d 1</td>
<td>37.2</td>
<td>28.5</td>
</tr>
<tr>
<td>Sub clin d14</td>
<td>29.7</td>
<td>19.9</td>
</tr>
</tbody>
</table>

P =
- Clinical Ketosis: .01
- Relapse: .05
- Sub clin d 1: .07
- Sub clin d14: .35
Effect of RPC on Health - All Cows

P = .72          .33         .77          .06          .001       .05

* Includes clinical ketosis
A Summary of Studies in Which Protected Choline was Fed to Transition Cows
Summary - Choline

- Supplemental protected choline prevents and alleviates fatty liver and reduces the incidence of ketosis
- Overall animal health is improved
- Supplementation of choline to transition cows increases milk and FCM production
Summary

• Altering pre-fresh diets seems to have little effect on postpartum performance.

• Restricting energy for the entire dry period may have modest positive effects on metabolic parameters; limited effects on postpartum production.

• Feed additives represent a means to reduce post-fresh lipid related metabolic orders and improve production; those that enhance lipid export from the liver are preferred.
Thanks!
Questions?