Physiological differences between metabolically stable and instable cows

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• The transition period for dairy cows is critically important to health and production
• In some cows adaptation to lactation is more successful than in other cows
• Past health status is usually not included in studies
To understand the differences in plasma parameters and mRNA levels of hepatic parameters during the transition period up to mid lactation in dairy cows characterized based on their past health status
Field study in Switzerland

- Cantons (states) Berne and Lucerne
Previous lactation: selection of the cows for the field study

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>milk fat percentage</td>
<td>&gt; 4.5 %</td>
</tr>
<tr>
<td>fat /protein ratio</td>
<td>&gt; 1.5</td>
</tr>
</tbody>
</table>

- Allocation to the farms
- Selection of farms with at least four cows
- 232 dairy cows of parities 2 to 13
- Breeds: Brown Swiss (98), Holstein Friesian (18), Red Holstein (74) and Simmental x Red Holstein (42)
Classification of cows as metabolically stable or instable

• Questionnaire

• prevalence of important production/metabolic diseases during the cow’s life
  – ketosis, milk fever, mastitis, endometritis, cystic ovarian disease, placental retention, displaced abomasum, claw problems
Scoring system

<table>
<thead>
<tr>
<th>Disease</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>ketosis, milk fever</td>
<td>10</td>
</tr>
<tr>
<td>mastitis, endometritis, cystic ovarian disease, placental retention,</td>
<td>2</td>
</tr>
<tr>
<td>displaced abomasums, claw problems</td>
<td></td>
</tr>
</tbody>
</table>

- Division by number of lactations
# Classification

<table>
<thead>
<tr>
<th>Group</th>
<th>Criteria</th>
<th>Number of cows</th>
</tr>
</thead>
</table>
| Stable | ≤ 2 points per lactation  
No occurrence of ketosis or milk fever | 154            |
| Instable | > 4 points per lactation  
Repeated occurrence of ketosis, milk fever, other met. diseases  
2 to 4 points per lactation  
Once ketosis or milk fever  
Repeated occurrence of disorders during 2nd lactation | 41             |
Current lactation: data and sample collection

- Blood and liver tissue samples
  - 3 weeks ante partum
  - 4 weeks and 13 weeks post partum
• Analysis of metabolites and hormone in blood plasma: BHBA, NEFA, glucose, urea, triglycerides, cholesterol, protein, albumin, $T_3$, $T_4$, insulin, IGF-I

• Quantitative determination of mRNA expression of hepatic enzymes and receptors by real-time RT-PCR
Materials & Methods

Glucose → Phosphoenolpyruvate

G6PC

CPT 1A
CPT 2
ACSL
ACADVL

Fatty acids

Pyruvate

Ketone bodies

HMGCS 2
BDH2

Acetyl-CoA

PEPCKm
PEPCKC

Cholesterol

Citric acid cycle

Nuclear receptor: PPARα

Amino acids

NH₃

Urea cycle
Statistical analysis

Mixed procedure from SAS including the fixed effects:

- **Group:**
  - Metabolically stable
  - Metabolically instable

- **Time-point:**
  - wk 3 a.p.

- **Breed type:**
  - Brown Swiss
  - Holstein
  - Red Holstein
  - Simmental x Red Holstein
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>milk (kg/d)</td>
<td>35.1 ± 0.5</td>
<td>35.1 ± 0.6</td>
<td>35.3 ± 0.9</td>
<td>34.2 ± 1.1</td>
</tr>
<tr>
<td>fat %</td>
<td>4.7 ± 0.1</td>
<td>4.3 ± 0.1</td>
<td>4.5 ± 0.1</td>
<td>4.2 ± 0.1</td>
</tr>
<tr>
<td>fat/protein ratio</td>
<td>1.4 ± 0.02</td>
<td>1.4 ± 0.03</td>
<td>1.4 ± 0.04</td>
<td>1.4 ± 0.04</td>
</tr>
</tbody>
</table>
Results: Glucose

<table>
<thead>
<tr>
<th>Week relative to parturition</th>
<th>Glucose mmol/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3</td>
<td>2.6</td>
</tr>
<tr>
<td>+4</td>
<td>3.0</td>
</tr>
<tr>
<td>+13</td>
<td>2.8</td>
</tr>
</tbody>
</table>

P-values:
- Time: < 0.01
- Group: 0.03
- Breed: 0.05
- Time x Groups: 0.24

Legend:
- □ Stable
- ▲ Instable

A

B

a

b
Results: Albumin

Week relative to parturition

P-values:
- Time: <0.01
- Group: 0.06
- Breed: 0.01
- Time x Groups: 0.63
Results: Insulin

Week relative to parturition

-3  +4  +13

Insulin µU/ml

Stable
Instable

P-values:
Time: < 0.01
Groups: 0.07
Breed: 0.59
Time x Groups: 0.28
Results: IGF-1

Week relative to parturition

IGF-1 ng/ml

Stable
Instable

Week relative to parturition

A

B

C

a

b

P-values:
Time: < 0.01
Groups: 0.06
Breed: 0.12
Time x Groups: 0.98
Results: $T_3$

Week relative to parturition:

-3 1.2 1.3 1.4

B

A

Stable

Instable

Time: < 0.01
Groups: 0.06
Breed: < 0.01
Time x Groups: 0.66
Results: HMGCS2

Veterinary Physiology

Week relative to parturition

-3  +4  +13

P-values:
Time: 0.20
Groups: 0.02
Breed: 0.41
Time x Groups: 0.80
Results: CPT1A

Veterinary Physiology

$\text{rel. mRNA expression (log}_2\text{)}$

-3 16 13 10

Stable Instable

Week relative to parturition

$P$-values:
- Time: $< 0.01$
- Groups: 0.04
- Breed: $< 0.01$
- Time x Groups: 0.85
Conclusion

• Grouping of cows according to past health status revealed differences in blood parameters and hepatic factors

• Milk production level did not seem to be related with metabolic instability

• Results suggest the presence of a genetic component underlying metabolism that in part determines the incidence of disorders
Thank you for your attention!