Genomic Selection for Improved Fertility of Dairy Cows with Emphasis on Cyclicity and Pregnancy
Monitoring Transition Management with Emphasis on Reproductive Performance

Ricardo C. Chebel

Department of Veterinary Population Medicine
The Impact of Health Disorders on Reproductive Efficiency
Incidence of Health Disorders in the First 60 DIM in High-Producing Holstein Herds

- 5,719 postpartum dairy cows evaluated daily for health disorders from eight experiments in seven dairy farms in the US

Healthy, Calving problem, Metritis, C. endometritis, Fever, Mastitis, Ketosis, Lameness, Pneumonia, Digestive

Incidence in the first 60 days postpartum, %

Courtesy: Dr. José E. P. Santos
Incidence of Health Disorders in the First 60 DIM in High-Producing Holstein Herds

- 5,719 postpartum dairy cows evaluated daily for health disorders from eight experiments in seven dairy farms in the US

Courtesy: Dr. José E. P. Santos
Incidence of Health Disorders in the First 60 DIM in High-Producing Holstein Herds

- 5,719 postpartum dairy cows evaluated daily for health disorders from eight experiments in seven dairy farms in the US

Incidence in the first 60 days postpartum, %

Healthy
Calving problem
Metritis
C. endometritis
Fever
Mastitis
Ketosis
Lameness
Pneumonia
Digestive

Incidence in the first 60 days postpartum, %
Peripartum Health Disorders are Associated with Resumption of Cyclicity by 60 DIM

Santos et al. (2010)
Peripartum Health Disorders are Associated with Resumption of Cyclicity by 60 DIM

Santos et al. (2010)
Peripartum Health Disorders are Associated with Resumption of Cyclicity by 60 DIM

Heath disorders = ↓ 5 a 25% cyclic cows

Cyclic cows, %

- Healthy: 80%
- 1 health disorder: 75%
- > 1 health disorder: 65%
- Dystocia: 70%
- Metritis: 70%
- Endometritis: 60%
- Fever postpartum: 80%
- Ketosis: 75%
- GI disorders: 55%

Santos et al. (2010)
Peripartum Health Disorders Affect Embryo Quality and Pregnancy Establishment

- Data from 5,719 lactating dairy cows evaluated daily for postpartum health disorders in 7 dairies in the USA

Peripartum Health Disorders Affect Embryo Quality and Pregnancy Establishment

- Quality of 476 d 6 embryos-oocytes from non-superstimulated cows:
  - Fertilization
  - Embryo quality
  - Cell population

- Data from 5,719 lactating dairy cows evaluated daily for postpartum health disorders in 7 dairies in the USA

Peripartum Health Disorders Affect Embryo Quality and Pregnancy Establishment

- Quality of 476 d 6 embryos-oocytes from non-superstimulated cows:
  - Fertilization
  - Embryo quality
  - Cell population

- Data from 145 cows that were flushed 15 d after AI and were classified according to:
  - Pregnancy
  - Development of embryos
  - Interferon-tau concentration

- Data from 5,719 lactating dairy cows evaluated daily for peripartum health disorders in 7 dairies in the USA

Summary of Estimates of Pregnancy at Different Stages after AI According to Health Status

Day after AI

Day 6

Pregnant, %

Healthy

Clinical disease

Bisinotto et al. (2012)

Courtesy: J. Santos
Summary of Estimates of Pregnancy at Different Stages after AI According to Health Status

<table>
<thead>
<tr>
<th>Day after AI</th>
<th>Healthy</th>
<th>Clinical Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 6</td>
<td>73.4%</td>
<td>57.5%</td>
</tr>
<tr>
<td>Day 15</td>
<td>49.3%</td>
<td>29.8%</td>
</tr>
</tbody>
</table>

Courtesy: J. Santos
Bisinotto et al. (2012)
Summary of Estimates of Pregnancy at Different Stages after AI According to Health Status

<table>
<thead>
<tr>
<th>Day after AI</th>
<th>Healthy</th>
<th>Clinical disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 6</td>
<td>73.4</td>
<td>57.5</td>
</tr>
<tr>
<td>Day 15</td>
<td>49.3</td>
<td>29.8</td>
</tr>
<tr>
<td>Day 30</td>
<td>51.4</td>
<td>34.7</td>
</tr>
</tbody>
</table>

Courtesy: J. Santos
Bisinotto et al. (2012)
Summary of Estimates of Pregnancy at Different Stages after AI According to Health Status

<table>
<thead>
<tr>
<th>Day after AI</th>
<th>Healthy (%)</th>
<th>Clinical Disease (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 6</td>
<td>73.4</td>
<td>57.5</td>
</tr>
<tr>
<td>Day 15</td>
<td>49.3</td>
<td>29.8</td>
</tr>
<tr>
<td>Day 30</td>
<td>51.4</td>
<td>34.7</td>
</tr>
</tbody>
</table>

Disease = 20 to 40% fewer pregnant cows

Courtesy: J. Santos
Bisinotto et al. (2012)
Metaphylactic Treatment of Cows at Risk for Uterine Diseases Does not Restore Fertility
Metaphylactic Treatment of Cows at Risk for Uterine Diseases Does not Restore Fertility

• Cows with RFM treated with ceftiofur (2.2 mg/Kg, 5 d; n = 31), or estradiol cypionate (4 mg once; n = 33), or control (n = 33) (Risco and Hernandes, 2003)
Metaphylactic Treatment of Cows at Risk for Uterine Diseases Does not Restore Fertility

• Cows with RFM treated with ceftiofur (2.2 mg/Kg, 5 d; n = 31), or estradiol cypionate (4 mg once; n = 33), or control (n = 33) (Risco and Hernandes, 2003)
  - Ceftiofur reduced incidence of metritis: ceftiofur = 13%, ECP = 42%, control = 42%
Metaphylactic Treatment of Cows at Risk for Uterine Diseases Does not Restore Fertility

- Cows with RFM treated with ceftiofur (2.2 mg/Kg, 5 d; n = 31), or estradiol cypionate (4 mg once; n = 33), or control (n = 33) (Risco and Hernandes, 2003)
  - Ceftiofur reduced incidence of metritis: ceftiofur = 13%, ECP = 42%, control = 42%
  - No benefits to reproductive performance (ECP compromised fertility)
Metaphylactic Treatment of Cows at Risk for Uterine Diseases Does not Restore Fertility

• Cows with RFM treated with ceftiofur (2.2 mg/Kg, 5 d; n = 31), or estradiol cypionate (4 mg once; n = 33), or control (n = 33) (Risco and Hernandes, 2003)
  - Ceftiofur reduced incidence of metritis: ceftiofur = 13%, ECP = 42%, control = 42%
  - No benefits to reproductive performance (ECP compromised fertility)

• Cows at risk treated with ceftiofur 6.6 mg of CCFA/Kg once (n = 317) or control (n = 304) (McLaughlin et al., 2013)
Metaphylactic Treatment of Cows at Risk for Uterine Diseases Does not Restore Fertility

- Cows with RFM treated with ceftiofur (2.2 mg/Kg, 5 d; n = 31), or estradiol cypionate (4 mg once; n = 33), or control (n = 33) (Risco and Hernandes, 2003)
  - Ceftiofur reduced incidence of metritis: ceftiofur = 13%, ECP = 42%, control = 42%
  - No benefits to reproductive performance (ECP compromised fertility)

- Cows at risk treated with ceftiofur 6.6 mg of CCFA/Kg once (n = 317) or control (n = 304) (McLaughlin et al., 2013)
  - Reduced number of days with high rectal temperature and reduced incidence of metritis (CCFA = 29% vs control = 42%)
Metaphylactic Treatment of Cows at Risk for Uterine Diseases Does not Restore Fertility

- Cows with RFM treated with ceftiofur (2.2 mg/Kg, 5 d; n = 31), or estradiol cypionate (4 mg once; n = 33), or control (n = 33) (Risco and Hernandes, 2003)
  - Ceftiofur reduced incidence of metritis: ceftiofur = 13%, ECP = 42%, control = 42%
  - No benefits to reproductive performance (ECP compromised fertility)
- Cows at risk treated with ceftiofur 6.6 mg of CCFA/Kg once (n = 317) or control (n = 304) (McLaughlin et al., 2013)
  - Reduced number of days with high rectal temperature and reduced incidence of metritis (CCFA = 29% vs control = 42%)
  - No improvements in performance
Effect of Preventative Treatment of Cows at Risk on Incidence of Metritis

McLaughlin et al. (2010)
## Performance of Cows at Risk for Metritis Treated Methaphylactically with Ceftiofur

<table>
<thead>
<tr>
<th>Item</th>
<th>Cows (Sites)</th>
<th>Treatment group</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culling ≤ 30 DIM,%</td>
<td>358 (9)</td>
<td>Control: 6.3 ± 1.8</td>
<td>3.3 ± 1.3</td>
</tr>
<tr>
<td>Cows sold+dead, %</td>
<td>358 (9)</td>
<td>23.6 ± 5.2</td>
<td>22.0 ± 4.9</td>
</tr>
<tr>
<td>305-d ME, Kg</td>
<td>278 (9)</td>
<td>12,037 ± 460</td>
<td>12,145 ± 461</td>
</tr>
<tr>
<td>Total milk production, Kg</td>
<td>289 (9)</td>
<td>8,909 ± 469</td>
<td>9,130 ± 462</td>
</tr>
<tr>
<td>Days in milk</td>
<td>355 (9)</td>
<td>244 ± 10</td>
<td>258 ± 9</td>
</tr>
<tr>
<td>Days open</td>
<td>295 (9)</td>
<td>147 ± 8</td>
<td>143 ± 7</td>
</tr>
<tr>
<td>Inseminations</td>
<td>324 (9)</td>
<td>2.89 ± 0.19</td>
<td>2.71 ± 0.17</td>
</tr>
</tbody>
</table>
Immune Function: Importance for Postpartum Health and Association with Dry Matter Intake
Effectors of Innate Immunity and Transition Cows

Adapted from L. G. D. Mendonça
Effectors of Innate Immunity and Transition Cows

L-selectin receptor

ICAM-1

Endothelium

Adapted from L. G. D. Mendonça
Effectors of Innate Immunity and Transition Cows

L-selectin

L-selectin receptor

ICAM-1

Endothelium

Adapted from L. G. D. Mendonça
Effectors of Innate Immunity and Transition Cows

L-selectin receptor

rolling

L-selectin

Endothelium

ICAM-1

Adapted from L. G. D. Mendonça
Effectors of Innate Immunity and Transition Cows

L-selectin receptor

rolling

CD-18

ICAM-1

Adapted from L. G. D. Mendonça
Effectors of Innate Immunity and Transition Cows

L-selectin rolling

L-selectin receptor

Firm adhesion

CD-18

ICAM-1

Endothelium

Adapted from L. G. D. Mendonça
Effectors of Innate Immunity and Transition Cows

L-selectin rolling

L-selectin receptor

CD-18 Firm adhesion

ICAM-1 Transmigration

Endothelium

Adapted from L. G. D. Mendonça
Effectors of Innate Immunity and Transition Cows

L-selectin

rolling

L-selectin receptor

CD-18

ICAM-1

Firm adhesion

Transmigration

Phagocytosis

Endothelium

Adapted from L. G. D. Mendonça
Effectors of Innate Immunity and Transition Cows

- L-selectin
- Rolling

- L-selectin receptor

- Firm adhesion
  - CD-18
  - ICAM-1

- Transmigration

- Oxidative burst

- Phagocytosis

Adapted from L. G. D. Mendonça
Effectors of Innate Immunity and Transition Cows

- Physiological and metabolic changes in the transition period affect immune function and susceptibility to postpartum diseases (Goff & Horst, 1997)

Adapted from L. G. D. Mendonça
Effectors of Innate Immunity and Transition Cows

- Physiological and metabolic changes in the transition period affect immune function and susceptibility to postpartum diseases (Goff e Horst, 1997)
- Neutrophil function is affected by cortisol (Burton et al., 1995) and NEB (Hammon et al. 2006)

Adapted from L. G. D. Mendonça
Effectors of Innate Immunity and Transition Cows

• Physiological and metabolic changes in the transition period affect immune function and susceptibility to postpartum diseases (Goff e Horst, 1997)

• Neutrophil function is affected by cortisol (Burton et al., 1995) and NEB (Hammon et al. 2006)

Adapted from L. G. D. Mendonça
Neutrophil Activity: Association with Dry Matter Intake and Metritis

Hammon et al. (2006)
Neutrophil Activity: Association with Dry Matter Intake and Metritis

Weeks Relative to Calving

Dry matter intake:
- Above median
- Below median

Health status:
- Healthy
- Mild metritis
- Severe metritis

Hammon et al. (2006)
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

• Possible uses of rumination/activity monitors:
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

- Possible uses of rumination/activity monitors:
  - Individual cow test to diagnose diseases
### Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

- **Possible uses of rumination/activity monitors:**
  - Individual cow test to diagnose diseases

<table>
<thead>
<tr>
<th>Test</th>
<th>Case</th>
<th>Case+</th>
<th>Case-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test+</td>
<td></td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>Test-</td>
<td></td>
<td>c</td>
<td>d</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test</th>
<th>Case</th>
<th>Case+</th>
<th>Case-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test-</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

- Possible uses of rumination/activity monitors:
  - Individual cow test to diagnose diseases

<table>
<thead>
<tr>
<th>Test</th>
<th>Case+</th>
<th>Case-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test+</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>Test-</td>
<td>c</td>
<td>d</td>
</tr>
</tbody>
</table>

Sensitivity = \( \frac{a}{a+c} \)
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

- Possible uses of rumination/activity monitors:
  - Individual cow test to diagnose diseases

<table>
<thead>
<tr>
<th>Test</th>
<th>Case+</th>
<th>Case-</th>
<th>Sensitivity = ( \frac{a}{a+c} ) upper = lower false -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test+</td>
<td>a</td>
<td>b</td>
<td>True (a) fonse (a+c)</td>
</tr>
<tr>
<td>Test-</td>
<td>c</td>
<td>d</td>
<td>False (d) fasc (a+c)</td>
</tr>
</tbody>
</table>
**Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield**

- Possible uses of rumination/activity monitors:
  - Individual cow test to diagnose diseases

<table>
<thead>
<tr>
<th></th>
<th>Case+</th>
<th>Case-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test+</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>Test-</td>
<td>c</td>
<td>d</td>
</tr>
</tbody>
</table>

Sensitivity = \( \frac{a}{a+c} \)

Specificity = \( \frac{d}{b+d} \)
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

- Possible uses of rumination/activity monitors:
  - Individual cow test to diagnose diseases

<table>
<thead>
<tr>
<th>Test</th>
<th>Case+</th>
<th>Case-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test+</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>Test-</td>
<td>c</td>
<td>d</td>
</tr>
</tbody>
</table>

Sensitivity = \frac{a}{a+c} = \frac{a}{a+c}

Specificity = \frac{d}{b+d} = \frac{b}{b+d}
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

- Possible uses of rumination/activity monitors:
  - Individual cow test to diagnose diseases

<table>
<thead>
<tr>
<th>Test</th>
<th>Case+</th>
<th>Case-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test+</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>Test-</td>
<td>c</td>
<td>d</td>
</tr>
</tbody>
</table>

Sensitivity = \( \frac{a \uparrow}{a+c} \) = \( \downarrow \) false - 

Specificity = \( \frac{d \uparrow}{b+d} \) = \( \downarrow \) false + 

PPV = \( \frac{a}{a+b} \)

\( \sum \) = \( \sum \) = false -

\( \sum \) = \( \sum \) = false +
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

- Possible uses of rumination/activity monitors:
  - Individual cow test to diagnose diseases

<table>
<thead>
<tr>
<th>Test</th>
<th>Case</th>
<th>Case+</th>
<th>Case-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test+</td>
<td>a</td>
<td>b</td>
<td></td>
</tr>
<tr>
<td>Test-</td>
<td>c</td>
<td>d</td>
<td></td>
</tr>
</tbody>
</table>

Sensitivity = \(\frac{a}{a+c}\)

Specificity = \(\frac{d}{b+d}\)

PPV = \(\frac{a}{a+b}\)

NPV = \(\frac{d}{c+d}\)
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

• Possible uses of rumination/activity monitors:
  – Individual cow test to diagnose diseases
    
    | Case  | Case+ | Case- |
    |-------|-------|-------|
    | Test+ | a     | b     |
    | Test- | c     | d     |

    Sensitivity = \( \frac{a}{a+c} \)
    Specificity = \( \frac{d}{b+d} \)
    PPV = \( \frac{a}{a+b} \)
    NPV = \( \frac{d}{c+d} \)

  – Monitor group rumination/activity: alterations in TMR, feed and water availability, stocking density
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

- Possible uses of rumination/activity monitors:
  - Individual cow test to diagnose diseases
    
    | Test | Case+ | Case- |
    |------|------|------|
    | Test+ | a    | b    |
    | Test- | c    | d    |

    | Test+ | Case+ | Case- |
    |------|------|------|
    | a    | b    |
    | c    | d    |

    Sensitivity = \( \frac{a}{a+c} \)
    
    Specificity = \( \frac{d}{b+d} \)

    PPV = \( \frac{a}{a+b} \)
    
    NPV = \( \frac{d}{c+d} \)

  - Monitor group rumination/activity: alterations in TMR, feed and water availability, stocking density
  - Monitor herd level prevalence of diseases
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

• Possible uses of rumination/activity monitors:
  – Individual cow test to diagnose diseases

<table>
<thead>
<tr>
<th></th>
<th>Case+</th>
<th>Case-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test+</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>Test-</td>
<td>c</td>
<td>d</td>
</tr>
</tbody>
</table>

Sensitivity = \( \frac{a}{a+c} \)

Specificity = \( \frac{d}{b+d} \)

PPV = \( \frac{a}{a+b} \)

NPV = \( \frac{d}{c+d} \)

– Monitor group rumination/activity: alterations in TMR, feed and water availability, stocking density
– Monitor herd level prevalence of diseases
– Averages may NOT be used to diagnose diseases
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

Liboreiro et al. (2014)
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

• Experiment conducted at a 2,700 lactating cow herd
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

- Experiment conducted at a 2,700 lactating cow herd
- Rumination and activity (SCR) determined from -17 to 17 d relative to calving (n = 300)
  - Rumination determined by a microphone (minutes rumination every 2 h)
  - Activity determined through an accelerometer (3D movement)

Liboreiro et al. (2014)
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

- Experiment conducted at a 2,700 lactating cow herd
- Rumination and activity (SCR) determined from -17 to 17 d relative to calving (n = 300)
  - Rumination determined by a microphone (minutes rumination every 2 h)
  - Activity determined through an accelerometer (3D movement)
- Metabolites (NEFA and BHBA) and haptoglobin concentration determined weekly from -21 to 21 d relative to calving

Liboreiro et al. (2014)
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

- Experiment conducted at a 2,700 lactating cow herd
- Rumination and activity (SCR) determined from -17 to 17 d relative to calving (n = 300)
  - Rumination determined by a microphone (minutes rumination every 2 h)
  - Activity determined through an accelerometer (3D movement)
- Metabolites (NEFA and BHBA) and haptoglobin concentration determined weekly from -21 to 21 d relative to calving
  - Ketosis = BHBA > 1,000 µmol/L between 0 and 21 d relative to calving

Liboreiro et al. (2014)
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

- Experiment conducted at a 2,700 lactating cow herd
- Rumination and activity (SCR) determined from -17 to 17 d relative to calving (n = 300)
  - Rumination determined by a microphone (minutes rumination every 2 h)
  - Activity determined through an accelerometer (3D movement)
- Metabolites (NEFA and BHBA) and haptoglobin concentration determined weekly from -21 to 21 d relative to calving
  - Ketosis = BHBA > 1,000 µmol/L between 0 and 21 d relative to calving
- Total Ca concentration determined on d 0, 1, 2, or 3 relative to calving

Liboreiro et al. (2014)
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

- Experiment conducted at a 2,700 lactating cow herd
- Rumination and activity (SCR) determined from -17 to 17 d relative to calving (n = 300)
  - Rumination determined by a microphone (minutes rumination every 2 h)
  - Activity determined through an accelerometer (3D movement)
- Metabolites (NEFA and BHBA) and haptoglobin concentration determined weekly from -21 to 21 d relative to calving
  - Ketosis = BHBA > 1,000 µmol/L between 0 and 21 d relative to calving
- Total Ca concentration determined on d 0, 1, 2, or 3 relative to calving
  - Sub-clinical hipocalcemia = Ca < 8.55 mg/dL

Liboreiro et al. (2014)
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

- Experiment conducted at a 2,700 lactating cow herd
- Rumination and activity (SCR) determined from -17 to 17 d relative to calving (n = 300)
  - Rumination determined by a microphone (minutes rumination every 2 h)
  - Activity determined through an accelerometer (3D movement)
- Metabolites (NEFA and BHBA) and haptoglobin concentration determined weekly from -21 to 21 d relative to calving
  - Ketosis = BHBA > 1,000 µmol/L between 0 and 21 d relative to calving
- Total Ca concentration determined on d 0, 1, 2, or 3 relative to calving
  - Sub-clinical hipocalcemia = Ca < 8.55 mg/dL
- Cows evaluated pre and post-partum for diseases, BCS, and LS

Liboreiro et al. (2014)
Association between Prepartum and Postpartum Rumination

Correlation: $r = 0.63$ ($P < 0.01$)
Partial correlation: $r = 0.65$ ($P < 0.01$)

Liboreiro et al. (2014)
Pattern of Rumination of Cows with Retained Placenta

Incidence = 13.2% (39/296)

RFM - $P = 0.69$
Day - $P< 0.01$
RFM $x$ day - $P< 0.01$

Liboreiro et al. (2014)
Pattern of Rumination of Cows with Metritis

Incidence = 21.2% (62/293)

Liboreiro et al. (2014)
Pattern of Rumination of Cows with Metritis

Criteria calculated 72 h post-partum:
Sensitivity = 75% and specificity = 93.1%

Incidence = 21.2% (62/293)

Liboreiro et al. (2014)
**Pattern of Rumination of Cows with Metritis**

Criteria calculated 72 h post-partum:
- Sensitivity = 75% and specificity = 93.1%
- Under treating metritic cows

Incidence = 21.2% (62/293)

Metritis - \(P = 0.16\)
- Day - \(P < 0.01\)
- Metritis x day - \(P = 0.22\)

Liboreiro et al. (2014)
Association among Rumination and Metabolites
Concentrations

Correlation: $r = -0.27\ (P < 0.01)$
Partial correlation: $r = -0.27\ (P < 0.01)$

Correlation: $r = 0.23\ (P < 0.01)$
Partial correlation: $r = 0.15\ (P = 0.03)$

Liboreiro et al. (2014)
Pattern of Rumination of Cows with Sub-clinical Ketosis

Incidence = 12% (30/249)

Liboreiro et al. (2014)
Pattern of Rumination of Cows with Sub-clinical Ketosis

Incidence = 12% (30/249)

sensitivity = 62.5%
specificity = 67.3%

Liboreiro et al. (2014)
Association between Rumination and Total Ca Concentration from 0 to 3 d Postpartum

Partial correlation: 
\( P = 0.003 \)  
\( r = 0.18 \)

Liboreiro et al. (2014)
Pattern of Rumination of Cows with Sub-clinical Hypocalcemia

Liboreiro et al. (2014)
Pattern of Rumination of Cows with Sub-clinical Hypocalcemia

Incidence = 37% (94/249)

SCHC: $P = 0.46$
SCHC x day: $P < 0.01$

Liboreiro et al. (2014)
Pattern of Rumination of Cows with Sub-clinical Hypocalcemia

Incidence = 37% (94/249)

Diagnosis must occur < 0 DIM

SCHC: $P = 0.46$
SCHC x day: $P < 0.01$

Liboreiro et al. (2014)
Pattern of Rumination of Cows with Sub-clinical Hypocalcemia

Incidence = 37% (94/249)  
1st criteria: sensitivity = 66.7% and specificity = 61.3%
2nd criteria: sensitivity = 82.7% and specificity = 49.6%

Diagnosis must occur ≤ 0 DIM

SCHC: $P = 0.46$
SCHC × day: $P < 0.01$

Liboreiro et al. (2014)
Pattern of Rumination of Cows with Sub-clinical Hypocalcemia

Incidence = 37% (94/249)

1st criteria: sensitivity = 66.7% and specificity = 61.3%
2nd criteria: sensitivity = 82.7% and specificity = 49.6%

Over treating normal cows

Diagnosis must occur ≤ 0 DIM

SCHC: $P = 0.46$
SCHC x day: $P < 0.01$

Liboreiro et al. (2014)
Association between Daily Milk Yield and Daily Rumination

Correlation: $P < 0.01 \quad r = 0.37$

Partial correlation: $P < 0.01 \quad r = 0.23$
Pattern of Rumination according to Milk Yield in the first 90 d Postpartum

All mature cows: n = 205

Days relative to calving

Rumination (min/d)
Pattern of Rumination according to Milk Yield in the first 90 d Postpartum

Healthy mature cows: n = 64

Days relative to calving

Rumination (min/d)
Utilizing Average Rumination Time to Identify Subpar Milk Yield

- Cows classified as the lowest 25 percentile milk yield up to 90 DIM
- Prepartum rumination time: not a good predictor of reduced milk yield
- Postpartum rumination time ≤ 408 min/d: sensitivity = 53.1% and specificity = 84%
  - PPV = 51%, NPV = 85%
- Pre and postpartum rumination time ≤ 481 min/d: sensitivity = 75.5% and specificity = 54.5%
Utilizing Average Rumination Time to Identify Subpar Milk Yield

- Cows classified as the lowest 25 percentile milk yield up to 90 DIM, no twins, no diseases
- Prepartum rumination time: not a good predictor of reduced milk yield
- Postpartum rumination time ≤ 384 min/d: sensitivity = 47.1% and specificity = 93.6%
  - PPV = 72%, NPV = 83%
- Pre and postpartum rumination time ≤ 433 min/d: sensitivity = 47.1% and specificity = 87.2%
Association Among Patterns of Rumination and Prevalence of Sub-clinical Ketosis
Association Among Patterns of Rumination and Prevalence of Sub-clinical Ketosis

\[ y = -0.2975x + 18.554 \]

\[ R^2 = 0.0289 \]

![Graph showing the relationship between Prepartum rumination pattern and prevalence of SCK](image)
Association Among Patterns of Rumination and Prevalence of Sub-clinical Ketosis

\[ y = -0.2975x + 18.554 \]
\[ R^2 = 0.0289 \]
Association Among Patterns of Ruminatión and Prevalence of Sub-clinical Ketosis

- **Prepartum rumination pattern**
  - Linear equation: $y = -0.2975x + 18.554$
  - $R^2 = 0.0289$

- **Prevalence of SCK**
  - Linear equation: $y = 1.4044x - 16.778$
  - $R^2 = 0.8754$
Association Among Patterns of Rumination and Prevalence of Sub-clinical Hypocalcemia

\[ y = 1.2122x + 12.154 \]

\[ R^2 = 0.2287 \]
Association Among Patterns of Rumination and Prevalence of Sub-clinical Hypocalcemia

\[ y = 1.2122x + 12.154 \]

\[ R^2 = 0.2287 \]
Association Among Patterns of Ruminations
and Prevalence of Sub-clinical Hypocalcemia

\[ y = 1.2122x + 12.154 \]
\[ R^2 = 0.2287 \]

\[ y = 3.4233x - 44.188 \]
\[ R^2 = 0.9817 \]
Association Among Patterns of Rumination and Prevalence of Stillbirth

\[ y = -0.0201x + 6.4512 \]

\[ R^2 = 0.0004 \]
Association Among Patterns of Rumination and Prevalence of Stillbirth

$y = -0.0201x + 6.4512$

$R^2 = 0.0004$

Prevalence of DOA

Prepartum rumination pattern
Association Among Patterns of Rumination and Prevalence of Stillbirth

\[ y = -0.0201x + 6.4512 \]
\[ R^2 = 0.0004 \]

\[ y = 0.8143x - 10.872 \]
\[ R^2 = 0.5777 \]
Association Among Patterns of Rumination and 90 d Milk Yield

\[ y = -0.0987x + 101.25 \]

\[ R^2 = 0.0124 \]
Association Among Patterns of Rumination and 90 d Milk Yield

\[ y = -0.0987x + 101.25 \]

\[ R^2 = 0.0124 \]
Association Among Patterns of Rumination and 90 d Milk Yield

\[ y = -0.0987x + 101.25 \]
\[ R^2 = 0.0124 \]

\[ y = -0.417x + 110.17 \]
\[ R^2 = 0.9441 \]
Use of New Technologies for the Diagnosis of Postpartum Diseases and Reduced Milk Yield

• More experiments are necessary to determine animal, nutrition, ambient, management factors associated with rumination of transition cows
  – Animals = parity, breed, twining, BCS
  – Dieta = NDF, peNDF, ADF, lignin, feed sorting
  – Ambient = Heat stress, stocking density, water availability

• Utilization of rumination and activity data for diagnosis of disease
  – The population is different than the individual
  – It is OK to say that in a population that has had rumination > “X” a drop in rumination time may indicate a problem
  – To diagnose a disease, rumination of the animal has to be compared to its rumination immediately before the disease occurs
Suggested Use of Rumination Information

• Continue your routine of fresh cow evaluation

• Daily pull out list of low rumination cows = these cows must have a full physical exam
  – Treat according to diagnosis and DVM protocol
  – If no disease is identified = supportive therapy (e.g. drench, Ca boluses)
  – Cows with no diagnosis = monitor rumination and examine the following day if rumination remains low

• Group evaluation
  – Monitor variability in rumination of close-up and fresh animals
  – Monitor rumination when changing diets, silage, and other important feed stuff
Long Term Effect of Reproductive Performance on Health and Vice-Versa
Association among BCS loss during the Dry Period and Performance

Mendonça and Chebel (unpublished)
Association among BCS loss during the Dry Period and Performance

• Data from 8,989 lactations from 6,183 multiparous Holstein cows

Mendonça and Chebel (unpublished)
Association among BCS loss during the Dry Period and Performance

- Data from 8,989 lactations from 6,183 multiparous Holstein cows
- Calving from 01/02 to 11/08 in two CA dairies
  - Dry lot and free stall dairies

Mendonça and Chebel (unpublished)
Association among BCS loss during the Dry Period and Performance

- Data from 8,989 lactations from 6,183 multiparous Holstein cows
- Calving from 01/02 to 11/08 in two CA dairies
  - Dry lot and free stall dairies
- Cows scored for BCS at dry-off and calving

Mendonça and Chebel (unpublished)
Association among BCS loss during the Dry Period and Performance

- Data from 8,989 lactations from 6,183 multiparous Holstein cows
- Calving from 01/02 to 11/08 in two CA dairies
  - Dry lot and free stall dairies
- Cows scored for BCS at dry-off and calving
  - Conventional dry cow diets (far-off and close-up)

Mendonça and Chebel (unpublished)
Association among BCS loss during the Dry Period and Performance

- Data from 8,989 lactations from 6,183 multiparous Holstein cows
- Calving from 01/02 to 11/08 in two CA dairies
  - Dry lot and free stall dairies
- Cows scored for BCS at dry-off and calving
  - Conventional dry cow diets (far-off and close-up)
- Planned dry period = 60 d (30 to 90 d dry period)

Mendonça and Chebel (unpublished)
Association among BCS loss during the Dry Period and Performance

- Data from 8,989 lactations from 6,183 multiparous Holstein cows
- Calving from 01/02 to 11/08 in two CA dairies
  - Dry lot and free stall dairies
- Cows scored for BCS at dry-off and calving
  - Conventional dry cow diets (far-off and close-up)
- Planned dry period = 60 d (30 to 90 d dry period)
- Prepartum stocking density varied from 80 to 100%

Mendonça and Chebel (unpublished)
Correlation between BCS at dry-off and Probability of BCS Loss in the Dry Period

Highly dependent on reproductive performance and milk yield

Mendonça and Chebel (unpublished)
Correlation between BCS at dry-off and Probability of BCS Loss in the Dry Period

Highly dependent on reproductive performance and milk yield

Mendonça and Chebel (unpublished)
Incidence of Health Disorders according to BCS Change during the Dry Period

<table>
<thead>
<tr>
<th>BCS Change</th>
<th>≥ +0.25 (n = 1.384, 15%)</th>
<th>0 (n = 3.852, 43%)</th>
<th>-0.25 to -0.5 (n = 3.551, 40%)</th>
<th>≤ -0.75 (n = 202, 2%)</th>
<th>( \beta )</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFM</td>
<td>3.0(^a),(^A)</td>
<td>3.4(^a),(^A)</td>
<td>5.5(^b)</td>
<td>7.4(^B)</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Metritis</td>
<td>10.0(^a)</td>
<td>12.3(^a)</td>
<td>15.7(^b),(^A)</td>
<td>20.8(^b),(^B)</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>GI disorders</td>
<td>2.6(^a)</td>
<td>2.4(^a)</td>
<td>4.8(^b)</td>
<td>9.9(^c)</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Removal by 30 DIM</td>
<td>3.0(^a)</td>
<td>2.8(^a)</td>
<td>5.1(^b)</td>
<td>12.9(^c)</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Removal by 60 DIM</td>
<td>5.1(^a)</td>
<td>4.5(^a)</td>
<td>7.6(^b)</td>
<td>15.4(^c)</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Culling rate (AHR and 95% CI)</td>
<td>0.88(^a) (0.77, 1.01)</td>
<td>Reference(^a)</td>
<td>1.14(^b) (1.04, 1.25)</td>
<td>1.73(^c) (1.36, 2.19)</td>
<td>&lt; 0.01</td>
</tr>
</tbody>
</table>

Mendonça and Chebel, 2011
Association between BCS loss during the Dry Period and Innate Immunity

Chebel et al. (2012)
Association between BCS loss during the Dry Period and Innate Immunity

- Data from 30 multiparous Holstein cows from the UofM dairy

Chebel et al. (2012)
Association between BCS loss during the Dry Period and Innate Immunity

- Data from 30 multiparous Holstein cows from the UofM dairy
  - Cows scored for BCS at -25 and 0 d relative to calving

Chebel *et al.* (2012)
Association between BCS loss during the Dry Period and Innate Immunity

- Data from 30 multiparous Holstein cows from the UofM dairy
  - Cows scored for BCS at -25 and 0 d relative to calving
  - Classified as having lost or gained/no change BCS

Chebel et al. (2012)
Association between BCS loss during the Dry Period and Innate Immunity

- Data from 30 multiparous Holstein cows from the UofM dairy
  - Cows scored for BCS at -25 and 0 d relative to calving
  - Classified as having lost or gained/no change BCS
  - Diets: NDF = 40 to 42% and NEL = 1.47 to 1.51 Mcal/kg

Chebel et al. (2012)
Association between BCS loss during the Dry Period and Innate Immunity

- Data from 30 multiparous Holstein cows from the UofM dairy
  - Cows scored for BCS at -25 and 0 d relative to calving
  - Classified as having lost or gained/no change BCS
  - Diets: NDF = 40 to 42% and NEL = 1.47 to 1.51 Mcal/kg
  - Blood sampled weekly from -14 to 21 d relative to calving

Chebel et al. (2012)
Association between BCS loss during the Dry Period and Innate Immunity

- Data from 30 multiparous Holstein cows from the UofM dairy
  - Cows scored for BCS at -25 and 0 d relative to calving
  - Classified as having lost or gained/no change BCS
  - Diets: NDF = 40 to 42% and NEL = 1.47 to 1.51 Mcal/kg
  - Blood sampled weekly from -14 to 21 d relative to calving
    - NEFA, cortisol, IGF-1, PMNL activity

Chebel et al. (2012)
Cortisol and IGF-I Concentrations According to BCS loss in the Close-up Period

Chebel et al. (2012)
Cortisol and IGF-I Concentrations According to BCS loss in the Close-up Period

Chebel et al. (2012)
Cortisol and IGF-I Concentrations According to BCS loss in the Close-up Period

Chebel et al. (2012)
NEFA Concentrations and PMNL Activity according to BCS loss in the Close-up Period

Chebel et al. (2012)
NEFA Concentrations and PMNL Activity according to BCS loss in the Close-up Period

Chebel et al. (2012)
NEFA Concentrations and PMNL Activity according to BCS loss in the Close-up Period

Chebel et al. (2012)
Association between Somatotropin Treatment and Immune Parameters
Association between Somatotropin Treatment and Immune Parameters

- GH deficient humans treated with somatotropin had a 50% increase in PMNL population
Association between Somatotropin Treatment and Immune Parameters

- GH deficient humans treated with somatotropin had a 50% increase in PMNL population

- Weaned piglets have ↑GH e ↓IGF-1 = similar endocrine pattern to transition cows in negative energy balance
Association between Somatotropin Treatment and Immune Parameters

• GH deficient humans treated with somatotropin had a 50% increase in PMNL population

• Weaned piglets have ↑GH e ↓IGF-1 = similar endocrine pattern to transition cows in negative energy balance

• Treatment of weaned and transported piglets with GH:
  – ↑IGF-1 concentration on the day after weaning
  – ↑IgM concentration on the day after weaning
  – ↑PMNL count and concentration
Association between Somatotropin Treatment and Immune Parameters

- GH deficient humans treated with somatotropin had a 50% increase in PMNL population

- Weaned piglets have GH e IGF-1 = similar endocrine pattern to transition cows in negative energy balance

- Treatment of weaned and transported piglets with GH:
  - ↑ IGF-1 concentration on the day after weaning
  - ↑ IgM concentration on the day after weaning
  - ↑ PMNL count and concentration

- Cows that lose BCS during the dry period have ↓ IGF-1
Effects of Peripartum rbST Treatment on Immune and Metabolic Responses
Effects of Peripartum rbST Treatment on Immune and Metabolic Responses

- Holstein cows (255 ± 3 d of gestation) allocated to 1 of 3 treatments:
  - 87.5 mg of rbST every 7 d = 12.5 mg/d (n = 53)
  - 125 mg of rbST every 7 d = 17.9 mg/d (n = 54)
  - Control = no rbST (n = 52)
Effects of Peripartum rbST Treatment on Immune and Metabolic Responses

- Holstein cows (255 ± 3 d of gestation) allocated to 1 of 3 treatments:
  - 87.5 mg of rbST every 7 d = 12.5 mg/d (n = 53)
  - 125 mg of rbST every 7 d = 17.9 mg/d (n = 54)
  - Control = no rbST (n = 52)

- Cows BCS ≥ 3.75 and locomotion score ≤ 2
  - Previous studies demonstrated that fat cows (> 3.75) had reduced IGF-1 between 7 and 14 d postpartum
Effect of rbST Peripartum Treatment on IGF-1 concentration of Holstein Cows

TRT - $P = 0.02$
Day - $P < 0.01$
TRT x Day - $P = 0.01$

Silva et al. (2014)
Effect of Peripartum rbST Treatment on PMNL intensity of Oxidative Burst

Silva et al. (2013)
Effect of rbST Peripartum Treatment on IgG concentration of Holstein Cows

Silva et al. (2013)
Effect of Peripartum rbST Treatment on BHBA concentration

Silva et al. (2013)
Effect of rbST Peripartum Treatment on Incidence of Metritis of Holstein Cows

TRT - $P = 0.09$
Control vs rbST - $P = 0.04$.

Silva et al. (2013)
Effects of Peripartum rbST Treatment on Immune and Metabolic Responses
Effects of Peripartum rbST Treatment on Immune and Metabolic Responses

• Treatment with 125 mg of rbST vs control:
  – ↑ IgG anti-ovalbumin prepartum
  – Tendency to increase hepatic glycogen 7 d prepartum
  – ↓ Metritis incidence (7.8 vs 23.1%)
  – Numerical increase in milk yield (~ 1.7 kg/d)
  – Tendency to decrease BCS from 28 to 90 DIM (0.25 unit)
  – Tendency for offspring to be ~ 5.5 lb heavier
Effects of Peripartum rbST Treatment on Immune and Metabolic Responses

- Treatment with 125 mg of rbST vs control:
  - ↑ IgG anti-ovalbumin prepartum
  - Tendency to increase hepatic glycogen 7 d prepartum
  - ↓ Metritis incidence (7.8 vs 23.1%)
  - Numerical increase in milk yield (~ 1.7 kg/d)
  - Tendency to decrease BCS from 28 to 90 DIM (0.25 unit)
  - Tendency for offspring to be ~ 5.5 lb heavier

- Will periparturient treatment with rbST:
  - Benefit thinner cows
  - Reduce the incidence of infectious and metabolic diseases
  - Increase milk yield
  - Affect the offspring
Managing the Obese Dairy Cows
Managing the Obese Dairy Cows

• Aggressive reproductive program = ↑ pregnancy rates
Managing the Obese Dairy Cows

• Aggressive reproductive program = ↑ pregnancy rates
• Extend the dry period offering low energy/high NDF diet during the far-off
Managing the Obese Dairy Cows

• Aggressive reproductive program = ↑ pregnancy rates
• Extend the dry period offering low energy/high NDF diet during the far-off
  – Will not prevent BCS loss but BCS loss will be more gradual, which is likely to minimize its impact on health
Managing the Obese Dairy Cows

• Aggressive reproductive program = ↑ pregnancy rates

• Extend the dry period offering low energy/high NDF diet during the far-off
  – Will not prevent BCS loss but BCS loss will be more gradual, which is likely to minimize its impact on health
  – Questions regarding economics???
Managing the Obese Dairy Cows

- Aggressive reproductive program = ↑ pregnancy rates
- Extend the dry period offering low energy/high NDF diet during the far-off
  - Will not prevent BCS loss but BCS loss will be more gradual, which is likely to minimize its impact on health
  - Questions regarding economics???
- Monensin supplementation = ↑ propionate = ↑ gluconeogenesis = ↑ improve liver function = ↓ ketosis
Managing the Obese Dairy Cows

- Aggressive reproductive program = ↑ pregnancy rates
- Extend the dry period offering low energy/high NDF diet during the far-off
  - Will not prevent BCS loss but BCS loss will be more gradual, which is likely to minimize its impact on health
  - Questions regarding economics???
- Monensin supplementation = ↑ propionate = ↑ gluconeogenesis = ↑ improve liver function = ↓ ketosis
- rbST treatment peripartum
Managing the Obese Dairy Cows

- Aggressive reproductive program = \( \uparrow \) pregnancy rates
- Extend the dry period offering low energy/high NDF diet during the far-off
  - Will not prevent BCS loss but BCS loss will be more gradual, which is likely to minimize its impact on health
  - Questions regarding economics???
- Monensin supplementation = \( \uparrow \) propionate = \( \uparrow \) gluconeogenesis = \( \uparrow \) improve liver function = \( \downarrow \) ketosis
- rbST treatment peripartum
  - \( \uparrow \) IGF-1 prepartum = \( \uparrow \) innate and adaptive immunity = \( \downarrow \) metritis (21 vs 7%)
Managing the Obese Dairy Cows

• Aggressive reproductive program = ↑ pregnancy rates

• Extend the dry period offering low energy/high NDF diet during the far-off
  – Will not prevent BCS loss but BCS loss will be more gradual, which is likely to minimize its impact on health
  – Questions regarding economics???

• Monensin supplementation = ↑ propionate = ↑ gluconeogenesis = ↑ improve liver function = ↓ ketosis

• rbST treatment peripartum
  – ↑ IGF-1 prepartum = ↑ innate and adaptive immunity = ↓ metritis (21 vs 7%)
  – ↓ BHBA = possible benefits to hepatic lipid metabolism
Thank you!!!

Ricardo C. Chebel

Department of Veterinary Population Medicine
College of Veterinary Medicine
University of Minnesota
chebe002@umn.edu
www.cvm.umn.edu