Use of Rumination and Activity Monitoring for the Identification of Dairy Cows with Health Disorders

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Health Monitoring SOPs
- Substantial variation across farms – frequency of checks, type of evaluation, labor demand and aids used
- Health monitoring programs –
  - costly
  - time consuming
  - require qualified labor
- Monitoring technologies
  - reduce or eliminate the burden associated with health monitoring programs

Early Lactation Challenges
- Health conditions to monitor post-partum period:
  - Retained placenta
  - Metritis
  - Mastitis
  - Displaced abomasum
  - Ketosis
  - Hypocalcemia
  - Diarrhea
  - Pneumonia

Identify sick cows → Treatment decisions → Improved well-being and productivity

Health monitoring programs – costly, time consuming, require qualified labor.

Sensor Data
- Active Bolus
Rumination-Activity Monitoring

HR-Tag, SCR Dairy

(1) Performance of the HR system to identify cows with health disorders (HD).

(2) When does the HR system identify cows with CD compared to farm personnel?

Rum-Act & Disease

Subclinical Ketosis
Liboreiro et al., 2015

Cornell University Research
Observational Prospective Cohort Study

N=1,121 cows
Study period: November 2013 to October 2014
Health Monitoring SOP

- Daily monitoring - all cows 1 to 10 DIM
  - Direct observation
  - Body Temperature
  - Ketostix (urine ketones)
  - Daily milk weights
- Rumen auscultation, check for DA
- Vaginal discharge - all cows at 8 DIM
- Milk culture - all cows at the beginning of lactation and mastitis cases
- Monitoring after 10 DIM: 3X milk weights and milk conductivity

Cornell University Research
Observational Prospective Cohort Study

1) Performance of the HR system to identify cows with health disorders (HD).

2) When does HR system identify cows with CD compared to farm personnel?
   - Cows grouped based on occurrence of HD (health disorder) and HI (health index) score
     - HD+ and HI+ (HI <86) disorder and flagged
     - HD+ and HI- (HI ≥ 86) disorder and NOT flagged
     - HD- (Healthy) healthy

Stangaferro et al., 2015 (Abstract: J. Dairy Sci. 98, E-Suppl 1)

Health Index Report

Evaluate the ability of Health Index (HI) score to identify cows with health disorders.

<table>
<thead>
<tr>
<th>Cow Number</th>
<th>Group</th>
<th>Lactation Status</th>
<th>Days in Lactation</th>
<th>Days From Last Breeding</th>
<th>Activity Peak</th>
<th>Rumination Peak</th>
<th>Daily Rumination</th>
<th>Amount of Evaluation</th>
<th>Health Index for Non</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20600</td>
<td>Before</td>
<td>4</td>
<td>-15</td>
<td>40</td>
<td>0</td>
<td>1</td>
<td>3.32</td>
<td>3.32</td>
</tr>
<tr>
<td>2</td>
<td>10565</td>
<td>Before</td>
<td>4</td>
<td>-15</td>
<td>40</td>
<td>0</td>
<td>1</td>
<td>3.32</td>
<td>3.32</td>
</tr>
<tr>
<td>3</td>
<td>50880</td>
<td>Before</td>
<td>4</td>
<td>-15</td>
<td>40</td>
<td>0</td>
<td>1</td>
<td>3.32</td>
<td>3.32</td>
</tr>
<tr>
<td>4</td>
<td>92512</td>
<td>Before</td>
<td>4</td>
<td>-15</td>
<td>40</td>
<td>0</td>
<td>1</td>
<td>3.32</td>
<td>3.32</td>
</tr>
<tr>
<td>5</td>
<td>12561</td>
<td>Before</td>
<td>4</td>
<td>-15</td>
<td>40</td>
<td>0</td>
<td>1</td>
<td>3.32</td>
<td>3.32</td>
</tr>
</tbody>
</table>

Stangaferro et al., 2015 (Abstract: J. Dairy Sci. 98, E-Suppl 1)

Abilty of HI Score to Identify Cows with Health Disorders

DA, KET, & IND

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Cows detected Se, % (95% CI)</th>
<th>HI &lt;86 to CD (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA (n = 41)</td>
<td>98 (93-100)</td>
<td>-3 (-3.7 to -2.3; P&lt;0.01)</td>
</tr>
<tr>
<td>Ketosis (n = 54)</td>
<td>91 (83-99)</td>
<td>-1.5 (-2.3 to -1.0; P&lt;0.01)</td>
</tr>
<tr>
<td>Indig. (n = 9)</td>
<td>89 (68-100)</td>
<td>-0.5 (-1.5 to 0.5; P=0.28)</td>
</tr>
<tr>
<td>All metabolic &amp; dig. (n = 104)</td>
<td>93 (89-98)</td>
<td>-2.1 (-2.5 to -1.6; P&lt;0.01)</td>
</tr>
</tbody>
</table>

Stangaferro et al., 2015 (Abstract: J. Dairy Sci. 98, E-Suppl 1)
Conclusions

- The HR system was effective to identify cows suffering metabolic and digestive disorders (DA, KET, IND).

- Cows with DA and KET identified earlier than farm personnel.

- No difference in milk for cows not flagged by HR (HD+ and HI-) and Healthy cows for 5 d prior to CD.

Displaced Abomasum

Activity, Rumination and HI patterns

Health Index Score

Healthy HI (-) (n = 1)

HI (+) (n = 7)

DRT (min/day)

Healthy: n = 435

HI-: n = 7

HI+: n = 92

All MET-DIG

Parameter Percent change 5 d preceding CD to nadir🏷️ P-value

DRT (min/day)

Healthy

HI-

HI+

≤0.5 ± 0.6b

15.8 ± 7.5a

-31.5 ± 3.9c

<0.001

ACT (AU/day)

≤2.8 ± 0.6a

-7.2 ± 4.6b

-13.1 ± 2.0a

<0.001

HI Score (AU/day)

≤-2.0 ± 0.3a

-1.2 ± 1.2a

-15.5 ± 3.0b

<0.001

Milk (kg/day)

11.1 ± 1.0a

3.9 ± 24.5b

-28.6 ± 4.4b

<0.001

Healthy: n = 435

HI-: n = 7

HI+: n = 92

Stangaferro et al., 2015 (Abstract: J. Dairy Sci. 98, E-Suppl 1)

Ability of HI Score to Identify Cows with Health Disorders

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Cows detected Se, % (95% CI)</th>
<th>HI &lt;86 to DCD (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metritis ALL</td>
<td>55 (49-60)</td>
<td>-1.2 (-1.6 to -0.7; P&lt;0.01)</td>
</tr>
<tr>
<td>≤39.4°C (n = 165)</td>
<td>56 (48-64)</td>
<td>-1.4 (-1.9 to -1.0; P&lt;0.01)</td>
</tr>
<tr>
<td>39.5-39.9°C (n = 79)</td>
<td>49 (38-61)</td>
<td>-1.3 (-2.9 to 0.4; P = 0.17)</td>
</tr>
<tr>
<td>≥40°C (n = 74)</td>
<td>58 (46-70)</td>
<td>-0.2 (-0.9 to 0.4; P = 0.46)</td>
</tr>
<tr>
<td>Antibiotic treatment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cephalosp. (n = 292)</td>
<td>49 (43-55)</td>
<td>-1.1 (-1.6 to -0.6; P = 0.17)</td>
</tr>
<tr>
<td>Ampi./Oxytet. (n = 57)</td>
<td>83 (70-91)</td>
<td>-1.4 (-2.1 to -0.7; P = 0.17)</td>
</tr>
</tbody>
</table>

Stangaferro et al., 2015 (Abstract: J. Dairy Sci. 98, E-Suppl 1)
**HI patterns**

**Metritis (Healthy, HI-, HI+)**

**HEALTH INDEX**

- Healthy (n = 451)
- HI (-) (n = 156)
- HI (+) (n = 184)

Group: P < 0.001
Day: P < 0.001
Group * Day: P = 0.005

**Milk Production – MET**

**Primiparous**

**Milk Production – MET**

**Multiparous**

**Culling Dynamics and Repro**

By HI Score (+ vs -)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Healthy</th>
<th>HI-</th>
<th>HI+</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNB/Sold &lt; 60</td>
<td>2.5* (15/451)</td>
<td>3.3* (15/313)</td>
<td>7.0* (13/187)</td>
<td>0.03</td>
</tr>
<tr>
<td>DNB/Sold total, %</td>
<td>18.6* (44/241)</td>
<td>14.4* (33/233)</td>
<td>31.0* (58/187)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>DIM at 1st AI, days (n)</td>
<td>79 (600)</td>
<td>79 (140)</td>
<td>80 (102)</td>
<td>0.73</td>
</tr>
<tr>
<td>P/AI at 1st AI, % (n/n)</td>
<td>46.0 (184/400)</td>
<td>42.9 (60/140)</td>
<td>45.9 (72/157)</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Cows in HI+ group twice as likely to leave the herd than cows in the HI- and Healthy group.

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Disease
Cows detected % Se (95% CI) HR Flag to DCD (days)
Mastitis (n = 165) 53 (45-61) -0.6 (-1.1 to -0.2; P<0.01)
  Clinical (n = 123) 58 (49-67) -1.2 (-2.7 to 0.3; P=0.12)
  Subclinical (n = 42) 41 (26-57) -0.5 (-1.0 to -0.1; P=0.02)
By Pathogen
  E. Coli. (n = 31) 81 (67-95) -0.5 (-1.1 to 0.2; P=0.18)
  Gram + (n = 39) 49 (32-65) -0.5 (-1.4 to 0.5; P=0.31)
  Staph. Aureus (n = 11) 46 (17-77) -1.4 (-4.1 to 1.3; P=0.23)
  No growth 48 h (n = 25) 48 (28-69) -0.2 (-1.4 to 1.1; P=0.78)

Stangaferro et al., 2015 (Abstract: J. Dairy Sci. 98, E-Suppl 1)

Parameter Percent change 5 d preceding CD to nadir
Healthy HI- HI+ P-value
DRT (min/day) 0.6 ± 0.9<sup>a</sup> -6.3 ± 3.7<sup>b</sup> -27.8 ± 5.1<sup>c</sup> <0.001
ACT (AU/day) 4.0 ± 1.2<sup>a</sup> 3.3 ± 2.9<sup>b</sup> -15.0 ± 2.6<sup>c</sup> <0.001
HI Score (AU/day) 0.4 ± 0.2<sup>a</sup> -1.4 ± 0.8<sup>b</sup> -13.4 ± 1.9<sup>c</sup> <0.001
Milk (kg/day) 4.1 ± 0.8<sup>a</sup> -9.2 ± 3.2<sup>b</sup> -21.9 ± 3.3<sup>c</sup> <0.001

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Health Index Score Performance

<table>
<thead>
<tr>
<th>% (n/n)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>False positives</td>
<td>2.4 (1.955/2.423)</td>
</tr>
<tr>
<td>Specificity</td>
<td>97.6 (70.695/72.423)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>95.6 (73.111/76.519)</td>
</tr>
</tbody>
</table>

- Each day was considered a new test
- Total number of days in the study was determined for individual cows until 80 DIM or DIM at which cows left the herd (sold or died)

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The HR system is most effective to identify cows suffering metabolic and digestive disorders.

A relatively lower Se to identify cows with MET and MAST might be explained by less severe systemic illness and type of mastitis-causing pathogen.

The HR system identified cows with DA, KET, MET and MAST earlier than farm personnel.

Opportunities
- Earlier treatment: improved response, improved well-being, prevent associated disorders

Challenges
- Treatment decisions in the absence of clinical signs? Prophylactic treatment?

On-farm use...
- Farms with little-to-no intervention identify more cows with health disorders
- Farms with intensive health monitoring reduce labor & cow manipulation
On-farm use...

- Add HI report to fresh cow check list
- Greatest benefit for DZ that occur after 3 DIM

Reduce number of cows to monitor

Acknowledgements

- Collaborating dairy farm
- SCR Dairy
- Students and technicians

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