Activity Monitors for Detection of Estrus in Dairy Cows

Paul M. Fricke, Ph.D.
P.D. Carvalho, J.O. Giordano, A. Valenza, G. Lopes Jr., M.C. Amundson
Detection Aids
Detection of Estrus-Related Odors in Cows by Trained Dogs

C. A. KIDDY,1 D. S. MITCHELL,2 D. J. BOLT 1 and H. W. HAWK1

Reproduction Laboratory,1
Animal Physiology and Genetics Institute, USDA, SEA, Beltsville, Maryland 20705
and
Department of Bioengineering, Behavioral Science Section,2
Southwest Research Institute, 6220 Culebra Road, San Antonio, Texas 78284
• 4 dogs were tested in a farmyard setting with live cows.
• Three cows, 1 in estrus and the other 2 between Days 6 and 12 postestrus, were used during each of 12 sessions of testing. New cows were used for each session.
• The dogs averaged **87.3%** correct detections of estrous cows.
Technology

Pedometry 1970’s

Radiotelemetry 1990’s
Accelerometer Systems

Heatime

Dairymaster

Select Sires

Select Detect
The nation’s top dairy counties — based on cows per square mile

Source: USDA 2002 Census of Agriculture
~10,500 dairy farms
~1.25 million dairy cows
SCR Systems in Wisconsin 2014
Hello Paul. I am a veterinarian in Fond du Lac county. I recently have had two herds purchase the SCR heat detection system.

My first question is that one of the dairymen asked me when he should breed the cows. Should he breed them as soon as they show up on the list, or is it better to wait some time before breeding and, if he should wait, how many hours before he should breed them?
Behavioral Estrus in Dairy Cows

When is the optimal time to AI?

~8 to 12 hours before ovulation

= ~12 h after onset of estrus
Question: How well does an increase in activity predict the time of ovulation?
Assessment of an accelerometer system for detection of estrus and treatment with gonadotropin-releasing hormone at the time of insemination in lactating dairy cows

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Majestic View Dairy
Lancaster, Wisconsin
Synchronization of estrus

Cows (n = 112) from 46 to 52 DIM were submitted to a G-P protocol to synchronize estrus:

GnRH

US + Blood

Mon

PGF$_{2\alpha}$

US + Blood + Kamar

Mon  Wed  Thu  Fri  Mon

3X US

Cows that failed to synchronize (n = 23) were excluded resulting in 89 cows included in the final analysis.
Percentage of cows determined to be in estrus, and distribution of cows by estrous activity and ovulation Valenza et al., 2012; J. Dairy Sci. 95:7115-7127

<table>
<thead>
<tr>
<th>Item</th>
<th>Accelerometer system</th>
<th>Heatmount detectors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-------- % (n/n) ------</td>
<td>-------- % (n/n) ------</td>
</tr>
<tr>
<td>Estrus</td>
<td>71 (63/89)</td>
<td>66 (59/89)</td>
</tr>
<tr>
<td>Ovulation</td>
<td>95 (60/63)</td>
<td>93 (55/59)</td>
</tr>
<tr>
<td>No ovulation</td>
<td>5 (3/63)</td>
<td>7 (4/59)</td>
</tr>
<tr>
<td>No Estrus</td>
<td>29 (26/89)</td>
<td>34 (30/89)</td>
</tr>
<tr>
<td>Ovulation</td>
<td>35 (9/26) 10%</td>
<td>47 (14/30)</td>
</tr>
<tr>
<td>No ovulation</td>
<td>65 (17/26) 20%</td>
<td>53 (16/30)</td>
</tr>
</tbody>
</table>
Characteristics of Activity

![Graph showing weighted activity and peak activity intensity over time]
Interval from AI to ovulation
Valenza et al., 2012; J. Dairy Sci. 95:7115-7127

Mean = 7.9 ± 8.7 h
n = 38 cows

Al too late (after ovulation)

Al too early (before ovulation)
Compromise for Time of AI

- Low fertilization rate, high embryo quality
- High fertilization rate, low embryo quality

Conception Rate (%)

- Insemination after Estrus Onset or G2 (h)
- Conception Rate (Nebel)
- Conception Rate (Pursley)
- Pregnancy Rate (Saake)

Ovulation

Insemination after Estrus Onset or G2 (h)
Relationship between duration of activity and the interval from onset of activity to ovulation

Valenza et al., 2012; J. Dairy Sci. 95:7115-7127

Cows (n = 38) that showed estrus within 96 h after induction of luteolysis

\[ y = 1.008x + 11.983 \]

\[ R^2 = 33\% \]
Ovsynch

Pursley et al., 1995; Theriogenology 44:915.

- GnRH
- PGF$_{2\alpha}$
- GnRH
- TAI

Ovulation

7 Days

56 h

16 h

24-32 h
Effect of AI to Ovulation Interval on Embryo Quality
Relationship between milk production and weighted peak intensity  
Valenza et al., 2012

\[ y = -0.309x + 56.474 \]
\[ R^2 = 16\% \]

\( n = 60 \text{ cows} \)
Duration of estrus in relation to milk production


- Analysis included all single ovulations (n=350) except first postpartum ovulations
- Average milk production during the 10 days before estrus

![Graph showing the relationship between milk production (kg/d) and duration of estrus (h)].

- Duration of estrus: 14.7 h for n=25, 9.6 h for n=65, 6.3 h for n=94, 4.8 h for n=73, 5.1 h for n=56, 2.8 h for n=37.

Milk production (kg/d):
- 20 kg/d
- 25 kg/d
- 30 kg/d
- 35 kg/d
- 40 kg/d
- 45 kg/d
- >50 kg/d
Hello Paul. I am a veterinarian in Fond du Lac county. I recently have had two herds purchase the SCR heat detection system.

My second question is what kind of breeding protocols work best with the system? Do you suggest presynching the cows? How many DIM before you intervene with a synch program and what program would you suggest?
Distribution of DIM at 1st Al Service

- Mar, 2000
- Jun, 2001
Presynch Ovsynch

Moriera et al., 2001; J. Dairy Sci. 84:1646-1659.
Presynch-Ovsynch with AI to estrus
Whole-Farm Drug Rehab Program
Genetic parameters for anovulation and pregnancy loss in dairy cattle

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*Dairy Science Department, University of Wisconsin, Madison 53706
†Department of Animal Sciences, University of Florida, Gainesville 32611-0910

5,818 records from 13 studies in 8 herds
prevalence = 23.3%

Figure 1. Observed prevalence of anovulation (bars) and number of cows (line) by category of BCS. An additional 118 records without BCS had 13.6% prevalence.
Reproductive performance of lactating dairy cows managed for first service using timed artificial insemination with or without detection of estrus using an activity-monitoring system

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Department of Dairy Science, University of Wisconsin, Madison 53706
Treatment 1

- Estrous activity and AI
- GnRH
- PGF
- GnRH
- TAI

14 d 7 d 56 h 12 h

Treatment 2

- PGF
- Estrous activity and AI
- GnRH
- PGF
- GnRH
- TAI

14 d 12 d 7 d 56 h 12 h

Treatment 3

- PGF
- Estrous activity and AI
- GnRH
- PGF
- GnRH
- TAI

7 d 56 h 12 h

DIM 39±3 VWP = 53±3 65±3 72±3 75±3
Effect of Treatment on Survival to First AI
Fricke et al., 2014; J. Dairy Sci. 97:2771-2781.
Treatment 2: Presynch-Ovsynch with AI to activity

Cows inseminated to activity
- 69% of cows
- P/Al at 35 d = 29% (n=230)

Progesterone at G1
- 2.1 ± 2.0 ng/mL
- 58% (51/88) High P4

Cows without activity receiving TAI
- 31% of cows
- P/Al at 35 d = 35% (n=105)
Treatment 3: Presynch/Ovsynch with 100% TAI

**Progesterone at G1**
- 2.6 ± 1.9 ng/mL
- 75% (153/205) High P4

**Cows with activity receiving TAI**
- 70% of cows
- P/Al at 35 d = 41% (n=232)

**Cows without activity receiving TAI**
- 30% of cows
- P/Al at 35 d = 32% (n=99)

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- **Calving**
- **DIM**
- **PGF**
- **PGF**
- **GnRH**
- **PGF**
- **GnRH**
- **TAI**

- 14 d
- 12 d
- 7 d
- 56 h
- 12 h

- Progesterone at G1
  - 1.7 ± 1.7 ng/mL
  - 55% (45/82) High P4

- Activity but no AI
Effect of treatment and parity on pregnancies per AI (P/AI).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Primiparous</th>
<th>Multiparous</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>36.5 (46/126)</td>
<td>27.7 (56/202)</td>
<td>0.10</td>
</tr>
<tr>
<td>2</td>
<td>32.3 (41/127)</td>
<td>30.4 (63/207)</td>
<td>0.72</td>
</tr>
<tr>
<td>3</td>
<td>47.3 (61/129)</td>
<td>32.7 (66/202)</td>
<td>0.01</td>
</tr>
<tr>
<td>Overall</td>
<td>38.7 (148/382)</td>
<td>30.3 (185/611)</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Fricke et al., 2014; J. Dairy Sci. 97:2771-2781
An economic decision-making support system for selection of reproductive management programs on dairy farms

J. O. Giordano, P. M. Fricke, M. C. Wiltbank, and V. E. Cabrera
Department of Dairy Science, University of Wisconsin, Madison 53706

<table>
<thead>
<tr>
<th>Farm Name</th>
<th>DY SCI 375 - Case Study 1</th>
<th>Location</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td>Wisconsin</td>
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1. Herd Parameters

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Lactating Cows, #</td>
<td>1,668</td>
</tr>
<tr>
<td>Lactation 1</td>
<td>778</td>
</tr>
<tr>
<td>Lactation 2</td>
<td>489</td>
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<tr>
<td>Lactation ≥ 3</td>
<td>441</td>
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<tr>
<td>Body Weight, lb/cow</td>
<td>1,350</td>
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<tr>
<td>Lactation 1</td>
<td>1,400</td>
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<tr>
<td>Lactation 2</td>
<td>1,450</td>
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<tr>
<td>Involuntary Culling, %/yr</td>
<td>29.4%</td>
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<tr>
<td>Mortality, %/yr</td>
<td>6.9%</td>
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<tr>
<td>Stillbirth, %/yr</td>
<td>9.0%</td>
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2. Economic Parameters

<p>| | |</p>
<table>
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<tr>
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<tbody>
<tr>
<td>Milk Price, $/cwt</td>
<td>16.87</td>
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<tr>
<td>Cost Feed Lactating, $/lb DM</td>
<td>0.10</td>
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<tr>
<td>Dry Period Fixed Cost, $/d</td>
<td>2.20</td>
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<tr>
<td>Female Calf Value, $</td>
<td>108</td>
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<tr>
<td>Male Calf value, $</td>
<td>44</td>
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<td>Heifer Replacement Value, $</td>
<td>1,288</td>
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<td>Cow Salvage Value, $</td>
<td>624</td>
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<tr>
<td>Cost of Birth, $</td>
<td>15.00</td>
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</table>

3. Lactation Curves (lb/cow/test)

<table>
<thead>
<tr>
<th>Test</th>
<th>Parity 1</th>
<th>Parity 2</th>
<th>Parity ≥ 3</th>
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<tbody>
<tr>
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<td>105</td>
<td>107</td>
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<tr>
<td>2</td>
<td>91</td>
<td>120</td>
<td>126</td>
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<td>3</td>
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<td>12</td>
<td>72</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>13</td>
<td>70</td>
<td>57</td>
<td>60</td>
</tr>
<tr>
<td>14</td>
<td>60</td>
<td>53</td>
<td>55</td>
</tr>
</tbody>
</table>

Department of Dairy Science
University of Wisconsin-Madison
Economic comparison
Fricke et al., 2014; J. Dairy Sci. 97:2771-2781

Net Present Value ($/cow/yr)

- Treatment 1: $2,728
- Treatment 2: $2,732
- Treatment 3: $2,736
Question: Does Ovsynch cause twinning?
Effect of Milk production on Multiple Ovulation Rate Lopez et al., J. Dairy Sci. 88:2783; 2005

DO = 3.6% (10/274) in nonlactating Holstein heifers
Rivera et al., 2004, 2005
A Breeder Apart: Farmers Say Goodbye to the Bull Who Sired 500,000 Offspring

Fans Commemorate ‘Toystory,’ a Dairy Legend With a Ravenous Libido

Toystory, a Wisconsin bull who set a record for semen production, was 2,700 pounds and sired an estimated 500,000 offspring. The famed bull died on Thanksgiving. PHOTO: GENEX
“I used to think Ovsynch caused twinning - until I tried to stop using Ovsynch”

Mitch Breunig
Mystic Valley Dairy
Sauk City, WI
Activity Graph
Activity + Rumination Graph

Weighted Activity And Rumination Change

- Activity Change
- Weighted Rumination Change
- Events

High Activity

Change

Date and Time

10:00 AM-12:00 PM
09/04/2011
10:00 AM-12:00 PM
15/04/2011
10:00 AM-12:00 PM
21/04/2011
10:00 AM-12:00 PM
27/04/2011
10:00 AM-12:00 PM
03/05/2011
10:00 AM-12:00 PM
09/05/2011
Summary & Conclusions

• Accelerometer technology is here to stay, and this and other technologies will continue to evolve and improve moving forward.

• Anovular cows represent a significant population of cows in herds that present a problem for accelerometer systems.

• Mean time of AI relative to ovulation determined by the accelerometer system was acceptable for some cows with increased activity; however, variability among cows in the interval from onset of activity to ovulation decreases conception rate to AI.
Summary & Conclusions

• A variety of strategies using a combination of AI based on increased activity and synchronization of ovulation and TAI can be used to submit cows for first AI.

• Some level of synchronization of ovulation and TAI will improve reproductive performance in almost all dairies.

• Conception rates to TAI appear to be greater for cows receiving TAI after a Presynch-Ovsynch protocol compared to cows receiving AI after increased activity.
Thank You!