#M110 Detection of Clinical and Subclinical Mastitis Using Reticulorumen Temperatures

A.E. Sterrett, K.N. Brock, B.I. Kiser, J.D. Clark, D.L. Ray, J.M. Bewley
University of Kentucky, Lexington, KY

INTRODUCTION

- Temperature can be useful for identifying changes in cow physiological status (Hewitt, 1921, Schlunsen et al., 1987, Seawright et al., 1983).
- Rectal temperatures are the gold standard in veterinary practice (Goodwin et al., 1998).
- Rectal temperatures are limited by human error in depth and duration of probe insertion and the presence of air or feces in the rectum (Bewley et al., 2008).
- Rectal temperatures are labor intensive, time consuming, and may result in rectal injuries (Bewley et al., 2008).
- Restraining animals to collect rectal temperatures may cause stress that alters temperature (Hahn et al., 1990; Prendiville et al., 2002).
- Reticulorumen temperatures accurately reflect core body temperature (Hicks et al., 2001, Prendiville et al., 2002, Bewley et al., 2008).
- Dramatic decreases in reticulorumen temperature occur after the cow drinks water (Dracy et al., 1963, Simmons et al., 1965, Bewley et al., 2008).
- Core body temperature is affected by numerous external factors.
- Automatic monitoring of core body temperature may be incorporated into dairy herd management.
- Changes in temperatures have been observed relative to mastitis and estrus events.

OBJECTIVE

The objective of this study was to examine the relationship between changes in reticulorumen temperature and subclinical and clinical mastitis.

MATERIALS AND METHODS

- This research was conducted at the University of Kentucky Coldstream Dairy (Lexington, KY).
- A biologically inert bolus (DVM Systems, LLC, Boulder, CO) resided in the cow's reticulorumen and was queried each time the cow passed a stationary reader panel (Figures 1 and 2).
- Reticulorumen temperatures were collected immediately before morning and afternoon milkings from 110 cows (71 Holstein, 22 crossbred, and 17 Jersey cows) from September 15, 2011 to June 28, 2012.
- General cow demographic information was obtained from PCDart (Dairy Records Management Systems, Raleigh, NC) records.
- Daily milk yields were obtained from the Milkline P4C™ (Milkline, Gariga di Podenzano, Italy) milking system.
- Mean parity, SCC, daily milk yield, and DIM were 2.1 ± 1.2, 222,735.8 ± 593,142.5 cells/mL, 36.3 ± 11.3 kg, and 175 ± 106 DIM, respectively.
- Raw reticulorumen temperatures were edited to remove erroneous reads and temperatures potentially influenced by water intake by first removing temperatures < 36.6°C and then removing temperatures with Z-scores < -2 from the cow's 10-day rolling average baseline.
- A composite milk sample was obtained from each cow every 14 days for SCC analysis (Fossomatic™ FC somatic cell counter, Foss, Hilleroed, Denmark).
- Subclinical mastitis events were established when SCC was ≥ 200,000 cells/mL.
- Milkers recorded clinical mastitis events from physical evaluation of milk (flakes, clots, or serous milk).
- Cow days were removed for two weeks after a clinical or subclinical mastitis event.
- Cow days were removed the day before, of, and after an estrus event.
- Cow days were removed when DIM ≥ 400.
- Reticulorumen temperatures were adjusted for the change in herd temperature at each milking to account for the effect of changing ambient and diurnal conditions.
- A 30-day rolling mean baseline reticulorumen temperature was calculated along with the number of SD from which each respective reticulorumen temperature varied from this baseline.
- A minimum of 14 reticulorumen temperatures were required to establish a baseline.

Figure 1. Anatomical view of a cow depicting reticulorumen bolus location.

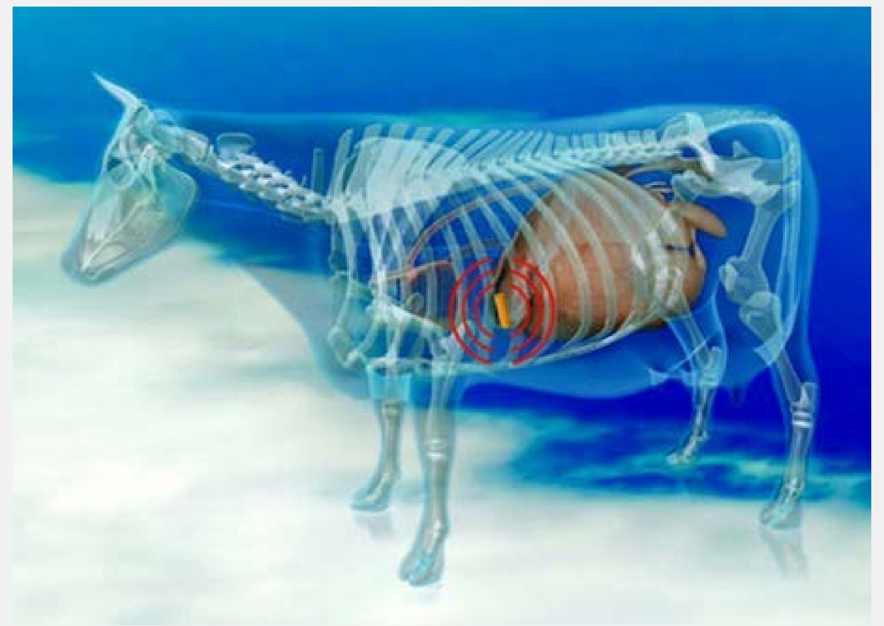

Figure 2. Enlarged DVM Systems reticulorumen temperature bolus.

RESULTS AND DISCUSSION

- When temperature increases were observed, the spikes were dramatic (Figures 3 and 4) indicating some potential for dairy cattle temperature monitoring.
- However, failure to identify most subclinical and clinical mastitis events demonstrates limitations.
- Even after considerable edits to eliminate the impact of drinking events, water intake may still limit reticulorumen temperature.
- 34 clinical mastitis events and 91 subclinical mastitis events were identified.
- Mean reticulorumen temperatures (N=46,768) among those recorded 2 d before mastitis events were 39.25 ± 0.47 and 39.20 ± 0.56 ºC for clinical and subclinical mastitis events, respectively (Table 1).
- The lowest false positive rates were obtained with a temperature threshold of 39.4ºC for clinical and subclinical mastitis cases (43% and 48%, respectively; Table 2).
- The highest clinical and subclinical mastitis detection rates were obtained using a 30 temperature observation window and 2 Z-score threshold. (Table 2)
- The lowest false positive rates were obtained using a 4 temperature observation window and a 3 Z-score threshold. (Table 2)
- The highest clinical and subclinical mastitis detection rates were obtained using a 39.4 ºC threshold (Table 2).
- The lowest false positive rates were obtained using a 40.3 ºC threshold (Table 2).
- When evaluating disease detection technologies, producers must consider both sensitivity and specificity.
- Differences among bacteriological cause of mastitis may explain variation in temperature responses with clinical and subclinical mastitis.
- More frequent temperature collection and multivariate combinations of temperatures with other mastitis indicators (i.e. electrical conductivity, activity, color analysis) may improve mastitis detection.
- Alternative data mining algorithms (i.e. neural networks, fuzzy logic) may improve mastitis detection.

Table 1. Descriptive statistics for observed temperatures associated with clinical and subclinical mastitis events.

Maximum adjusted temperature among recordings 2 days before mastitis event (ºC)	N	Mean	SD	Min	Max
Clinical Mastitis Event	34	39.25	0.47	38.27	40.20
Subclinical Mastitis Event	91	39.20	0.56	38.34	40.51

Figure 3. Temperature changes around a subclinical mastitis event.

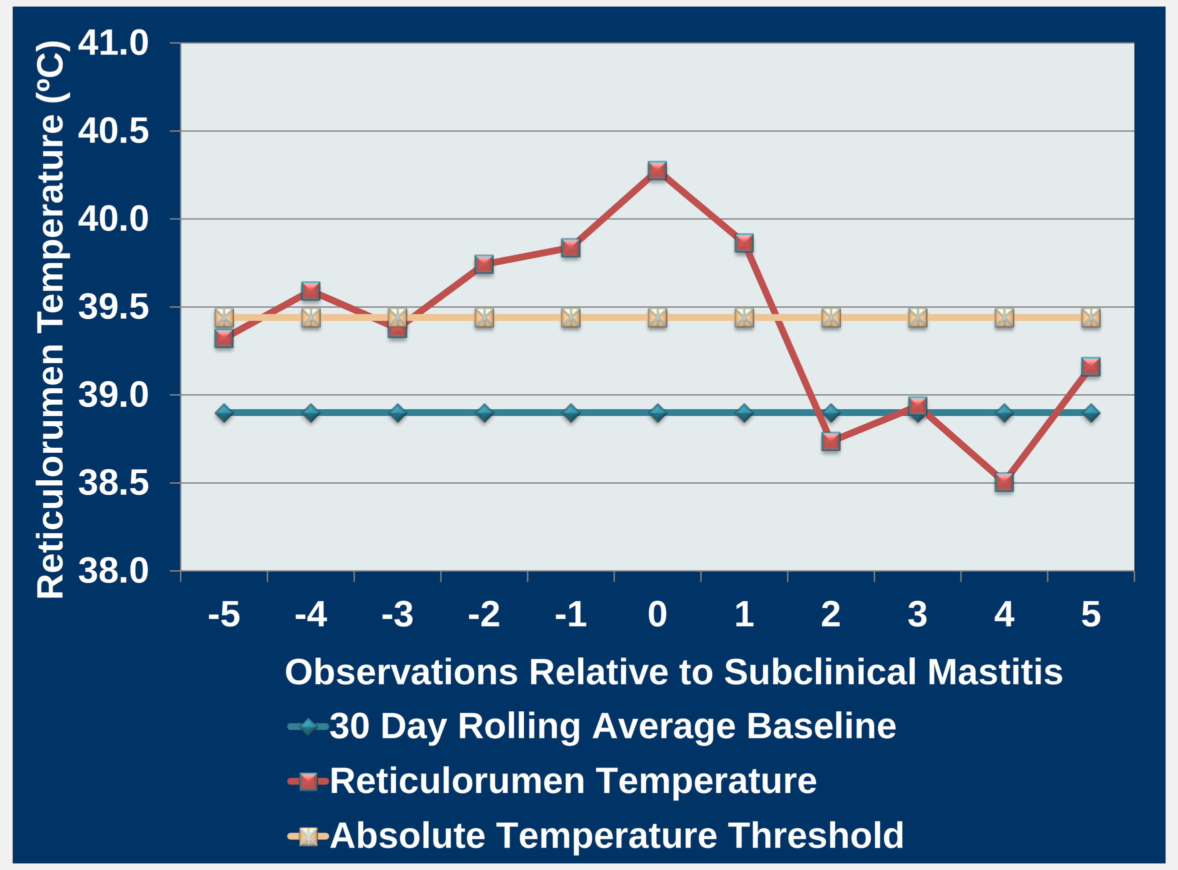

Figure 4. Temperature changes around a clinical mastitis event.

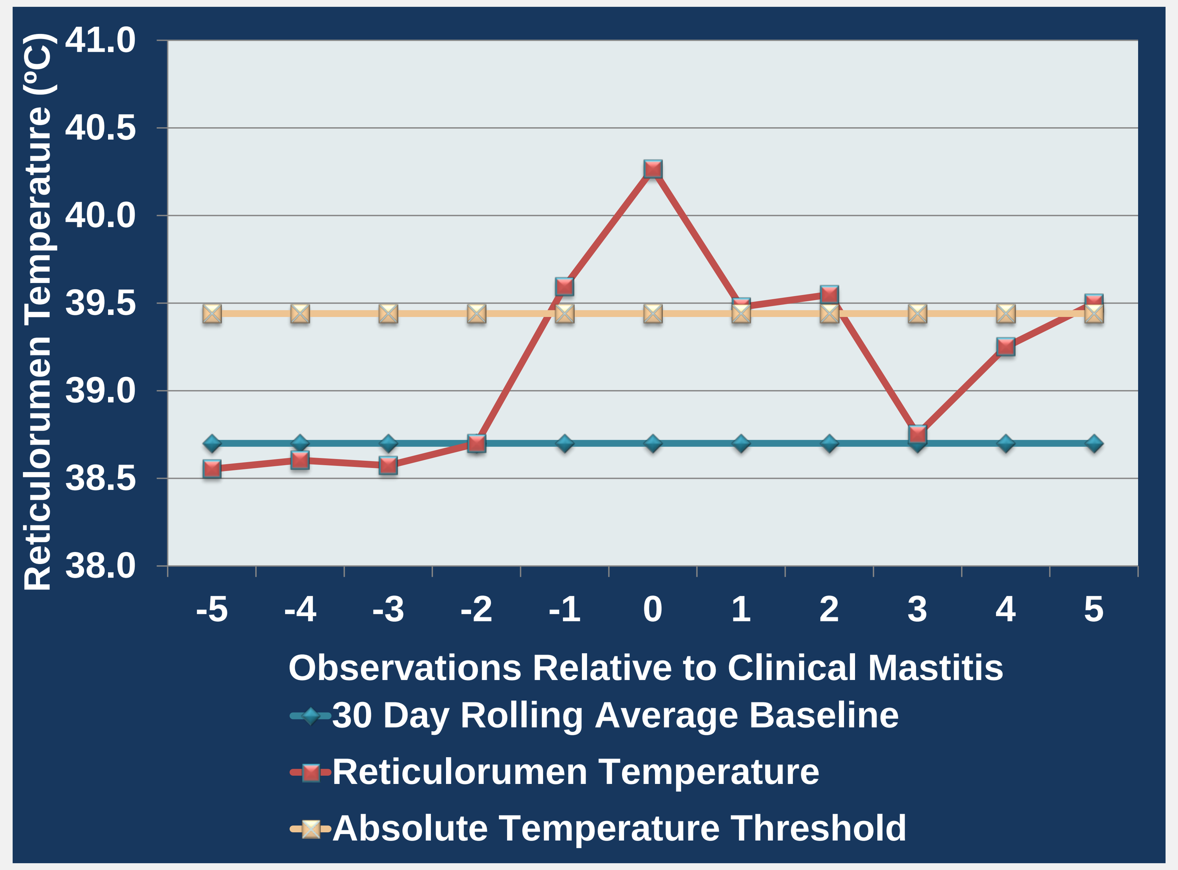

Table 2. Clinical and subclinical mastitis detection and false positive rates for varying alert thresholds.[1]

Z-score / Temperature Threshold	Observation Window	Clinical Mastitis		Subclinical Mastitis		Healthy Quarter	
		% Above Threshold	% Below Threshold	% Above Threshold	% Below Threshold	% Above Threshold	% Below Threshold
2	4	14	86	5	95	7	93
3	4	2	98	1	99	1	99
2	10	29	71	17	83	15	85
3	10	9	92	2	98	3	97
2	20	42	58	34	66	26	74
3	20	12	88	7	93	6	94
2	30	44	56	41	59	35	65
3	30	14	86	9	91	8	92
40.3ºC	4	5	95	6	94	3	97
40.0ºC	4	16	84	12	88	7	94
39.7ºC	4	41	60	22	78	13	87
39.4ºC	4	43	57	48	52	23	77

[1] Shading denotes highest detection and lowest false positive rates among threshold combinations.

CONCLUSIONS

- Reticulorumen temperature may be an indication of subclinical and clinical mastitis.
- Natural variation in cow body temperatures may limit the utility of reticulorumen temperatures.
- More frequent temperature recording may be necessary to unlock the full potential of dairy cattle temperature monitoring.

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