

Latest Thoughts on Methods for Assessing Teat Condition

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The Teat Club International (TCI) is an excellent example of an interdisciplinary and international cooperative effort and illustrates the synergies that such collaboration can produce. The group of experts cited in the references to this paper (lead by Graeme Mein, then Eric Hillerton and now Ian Ohnstad) began a dialogue intended to develop a commonly accepted methodology for assessing teat condition. This effort has facilitated scientific progress by allowing these common methods to be used by researchers and field investigators around the world so that results could be pooled, compared, and communicated using a common language.

The first series of TCI papers was presented at the 2001 International Symposium on Mastitis and Milk Quality sponsored by the NMC and the AABP in Vancouver, BC, Canada.

- *Evaluation Of Bovine Teat Condition In Commercial Dairy Herds:*
 1. *Non-Infectious Factors*
 2. *Infectious Factors and Infections.*
 3. *Getting the Numbers Right.*
- *Teat-End Callosity Or Hyperkeratosis And Mastitis*

Several additional TCI papers have been published in the intervening 6 years culminating with the final paper of this session, *Addressing Teat Condition Problems*, which combines the collective experience and knowledge of the TCI to suggest successful solutions for teat condition problems.

This paper, *Latest Thoughts on Methods for Assessing Teat Condition*, will present a case study of a TCI investigation performed in Wisconsin along with this authors' views on methods best suited for field application.

The list of teat conditions and their target criteria presented by the TCI in 2001 were:

Teat Condition Measure	Criteria	Diagnosis				
		- -	-	o	+	++
1. Color	> 20% visibly reddened or blue					
2. Swelling at Teat Base	> 20% swelling or palpable rings					
3. Swelling at Teat End	> 20% firm, hard or swollen					
4. Openness	> 20% classified as open					
5. Vascular Damage	> 10% petechiations					
6. Teat End Roughness	> 20% Rough and Very Rough					
7. Open Lesions	> 5% open lesions or cracked skin					

TCI recommendations were to score teat condition using a pass/fail criterion on all teats of all cows in the herd if time and herd size allow, or randomly select at least 80 cows or 20% of the herd (whichever is largest number of cows). Tables were presented to record the statistical

interest to the diligent investigator is the ability to detect biologically important differences with the maximum efficiency (minimum sample size). The relative merits of the visual versus photographic approaches will be discussed in this regard.

In the experience of this investigator (and he suspects many others) scoring teats for all of the conditions indicated above is a super-human task. It is particularly difficult to perform these evaluations in a large milking parlor without undue disruption of the milking routine. Furthermore, it would be difficult for an investigator to bill the time required to do a complete investigation to a client who may be less than enthused about the condition of their teats.

Teat condition is important for several reasons

- There is a weak correlation between increased teat-end hyperkeratosis (HK) and increased risk of new mastitis infections (HK is apparently not the primary causal factor in udder infection).
- Some measures of teat condition give an indication of the stresses applied during milking and the resulting tissue congestion and ability of the teat canal to seal effectively when cows return to their housing environment.
- Teat condition can give some indication of the comfort level of cows during milking, especially at the low flow period at the end of milking. It is not uncommon for cows to become ‘jumpy’ or to begin kicking at the milking unit during the low flow period, during which teat congestion is most pronounced.

It became clear, on the first visit to this case-study farm that many of the 8 conditions listed in the above data collection form were not of concern on this farm. The primary concerns as indicated by discussions with milking personnel and an initial inspection of cows were: teat color, ringing at the base of teats, teat end roughness, and completeness of milking. It also became apparent during initial investigations that there were a significant number of cows that kicked and stepped during this strip yield assessment.

The investigation was modified to focus on these issues that appeared most important based on discussion with the dairy operator and initial evaluations. A simplified scoring sheet was developed as follows (also available for download at www.uwex.edu/uwmrl):

Simplified Data collection Form Example

Date		Farm																				
To make use of auto statistics feature: put an "x" (lower case) in the box for "bad" teats, put "o" (lower case Oh) in the box for normal teats. Leave box blank for teats not scored.																						
Observations	Cow #	Teats Red or Blue				Teat Rings				Teat end Rough or VR				Lesions/Other				Strip Yield > 100 ml				Observations
		rf	rr	lr	lf	rf	rr	lr	lf	rf	rr	lr	lf	rf	rr	lr	lf	rf	rr	lr	lf	
1		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1	
2		o	x																		2	
3		o		x																	3	
4		o			x																4	

The ‘other’ category in the simplified data collection form was used to record the number of cows that kicked at the investigator while he was hand stripping teats after unit removal.

A digital dictation machine was used to record cow number (as indicated by the automatic ID system) and the teat conditions observed for each cow. This method made teat scoring much faster. It would not have been possible to score this number of condition types and cows if the investigator had to carry a pad of paper and write observations between cows. This farm was milking about 700 cows and the investigator attempted to score as many cows as possible from the entire herd, immediately after units were removed and without undue disruption of the milking routine. Following are the results of the first teat scoring:

<u>Condition</u>	<u>Total Number Scored</u>	<u>Percent Problematic</u>
Teat skin Red or Blue	Cows 323	80%
	Teats 1274	76%
Rings at the Teat Base	Cows 348	20%
	Teats 1374	15%
Teat Ends Rough or Very Rough	Cows 347	50%
	Teats 1367	38% (43% Front / 33% Rear)
Kicking Cows	Cows 348	38%
Hand Strip Yield	Cows 342	2%
	Teats 1353	1% (2% Front / 1% R)

There were some serious concerns on this farm with the condition of the teats at the time of this first investigation. The percentage of red of blue teats was extreme (80% of cows and 76% of teats with no significant difference between quarters). The teat end roughness scores (50% of cows and 38% of quarters with cracked, hyperkeratotic teat ends) was also excessive. There was a slightly higher incidence of teat roughness in front quarters.

The occurrence of ‘ringing’ at the base of the teat (20% of cows and 15% of quarters) was moderate. Thirty-eight percent of cows stepped or kicked when being hand stripped, which the investigator consider to be excessive based on his experience of teat assessment. A substantial percentage of cow’s also kicked at the milking units in the low flow period. The cows were, however milked out very completely with 2% of front quarters and 1% of rear quarters with more than 100 ml of milk harvested by hand milking immediately after unit removal.

It was speculated that the combination of the type of liner with the relatively high milking vacuum was a major contributor to teat congestion (red and blue teat color) hyperkeratosis (rough teat ends) and cow discomfort (cows stepped and kicking when hand stripped) on this farm.

This liner in use had a relatively high mouthpiece vacuum (accounting for ringing and red/blue color at the base of the teats) as well as a relatively high compressive load (accounting for the rough teat ends). These findings were explained to the herdsman and owner, who decided to try a different liner.

Teat condition was assessed again one month later with the following results.

Condition	Total Number Scored	Percent Problematic
Teat skin Red or Blue	Cows 295	79%
	Teats 1144	74%
Rings at the Teat Base	Cows 341	3%
	Teats 1347	3%
Teat Ends Rough or Very Rough	Cows 347	66%
	Teats 1347	47% (54% Front / 41% Rear)
Kicking Cows	Cows 341	26%
Hand Strip Yield (>100 ml/quarter)	Cows 341	19%
	Teats 1353	10%

The subjective impression of the investigator during this second evaluation was that teat condition was very much better with much improvement in teat color at the base of the teats but there were still a significant number teats with pronounced redness at the teat end (probably because the milking vacuum remained at the same high level). Quantitatively, using a pass/fail test, the percentage of red/blue teats was unchanged from the first evaluation, however.

The percentage of teats scored with rings at their base was substantially reduced to an 'excellent' level. The percentage of teats scored rough or very rough showed no statistically significant change. The percentage of cows scored as 'kickers' decreased somewhat but the subjective impression of the investigator was that cows were much calmer after the units came off than during the previous visit. The percentage of teats with some residual milk increased slightly but was still in the 'very good' range.

The average flow rate (lb/min) as recorded by the farms milk meters, decreased by 9% and the peak flow rate decreased by 3% ($p=0.003$) with the new liners, probably because of changes in the true milk:rest ratio and could have been avoided by altering the pulsation setting. Milk yield per cow was unchanged ($p=0.88$) and the average unit-on duration increased by about 12 seconds. The impressions of the herdsman were that the average flow rate had not changed much (perhaps a bit higher) while the cows milked per hour had gone up, and that they were seeing less red teats, and slightly more liner slips.

Photographic Study

During the first visit to the farm, the right rear teats of as many cows as practical were digitally photographed with a recording of the cow ID (as indicated by the automated ID system). Of the 700 milking cows about 130 photographs were taken during the first investigation. During the second investigation this list of cow numbers was used to re-photograph as many cows as practical. The photographs of presumably the same teats were scored to assess whether teat condition measures of color, rings and roughness had improved, stayed the same, or gotten worse over the course of the 1 month test period. This exercise had the side benefit of assessing the accuracy of cow ID (which appeared to be about 90%).

The result of 67 confirmed “within cow” teat photographs were as follows:

Teat Condition	Better	Same	Worse
Color	78%	23%	0%
Rings	35%	65%	0%
Roughness	29%	62%	10%

This paired test of teat condition indicates that teat color improved (less blue or red color) for about $\frac{3}{4}$ of cows, stayed the same for about $\frac{1}{4}$ and became worse for no cows. Teat color is likely the teat condition to show the fastest response to a change in milking conditions. Ringing at the base of the teat and teat end roughness were less pronounced for about $\frac{1}{3}$ of cows, the same for $\frac{2}{3}$ of cow. No cows had more pronounced ringing and about 10% of cows had rougher teat ends. Ringing and teat end roughness would be expected to change more slowly than teat color and it would be expected that teat ends would become slightly more roughened over the course of 1 month of the same milking conditions.

Confounding with Time

These two evaluations, performed one month apart, suffer from a potential confounding with time, and the results must therefore be interpreted accordingly. For example, there could be some factor, unrelated to the change in liners that caused various aspects of teat condition and milking performance to change. The most obvious among these potential confounders is a change in environmental conditions, known to have a profound influence on teat end roughness.

The best way to control against such confounding is to use a control group, for which the causal variable of interest is not changed, or to use a ‘switchback’ design in which the causal variable is changed, then switched back to the original condition and then changed to the new condition again. These methods are, however, often not practical in routine field investigations.

A careful choice of the time interval between tests (just long enough to elicit the expected response, but not so long that external variables will change dramatically) and the time of year (avoiding times when external factors are known to occur) can reduce the confounding problem. A knowledge of the underlying physiological basis and time scale for changes in teat condition and milking performance is also helpful in avoiding interpretation errors. And of course, statistics is our friend in separating the ‘noise’ of random changes from the ‘signal’ of a real change.

Post Script

Several aspects of teat condition were noticeably improved when a different liner was used on this farm without a change in milking vacuum or pulsation settings. In the view of this investigator, the milking vacuum was still slightly excessive. This issue was discussed with the herd manager, who subsequently decided to reduce the system vacuum by about 2 kPa. Although teat condition was not reassessed, the herdsman reported that this lower vacuum level resulted in no change in cows/hour milked in the parlor, overall improvement in milking performance and a reduction in bulk tank SCC.

Conclusions and Recommendations

- Know what you are looking for. It is impractical to perform the entire range of tests available to assess teat condition and milking performance on every farm. Discussions with milking personnel and an initial assessment of a few turns of cows will enable the investigator to determine the most interesting and likely causes for concern in the herd. After this cursory investigation a more targeted and quantitative investigative approach should be devised.
- Digital recording technology is very helpful. The use of a digital dictation machine makes the job of recording visual observations much easier and improves data quality. This is especially true on large farms milking around the clock, for which a disruption in the milking routine is undesirable. Some of the time saved writing during assessment must, however, be used to subsequently enter data into an analysis program. Digital voice recording also facilitates documentation of useful information, not anticipated in the data collection protocol.
- Paired photographic tests are much more efficient at detecting changes than pass/fail visual indicators. The visual pass/fail observations showed little or no difference in either teat color or teat-end roughness in this case study while the paired photographic (and subjective) evidence indicated dramatic changes in these measures of teat condition. The paired photographic test was, in addition, far easier to implement than the enormous sample visually scored. Photographic evidence also allows a 'second chance' to evaluate subtle differences not captured by the simple pass/fail criteria devised in the data collection protocol (such as changes in teat color at the base versus end of teats).
- Follow-up and confirm your recommendations. In order to build your expertise as an investigator, and for the benefit of your client, it is highly desirable to reassess critical performance indicators to determine if an intervention was implemented and if it produced the expected result. And remember, statistical analysis can be our friend.

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