AUTOMATIC MILKING. HOW TO DEFINE A THRESHOLD FOR DUMPING MASTITIC MILK?

Morten Dam Rasmussen
Danish Institute of Agricultural Sciences, Foulum, DK-8830 Tjele, Denmark

Introduction

Detection of mastitis in automatic milking systems is mainly based on the measurement of electric conductivity of the milk. It is generally believed that conductivity will detect changes in the milk before clinical signs develop. However, detection of chronically infected quarters by this method is more questionable. Currently, the golden standard of acceptable milk of cows is based on visual inspection of foremilk. Cows without clots or blood in the foremilk normally deliver milk for consumption. Detection of clots in the foremilk depends on the skills of the milker and of the practical conditions under which the foremilking is performed. Hillerton (2000) states that the sensitivity is 80% for detecting cows with clinical mastitis during foremilking but the specificity is 100%. If clots can be found in the milk at any time during milking, the quarter suffers from clinical mastitis. It becomes more difficult if the selection criterion is determined on somatic cell count (SCC). Bulk milk SCC is used as the main criterion for acceptable milk in relation to subclinical mastitis but also as an indicator when to dump milk from cows with clinically abnormal foremilk. A threshold of 400,000 cells/ml is used in the European Union, 500,000 cells/ml in Canada, and 750,000 cells/ml in the USA. The expected frequencies of infected cows are 13, 16, and 24% at a bulk milk SCC of 400,000, 500,000, and 750,000 cells/ml respectively (Eberhart et al., 1982). Classification of the inflammatory status of a quarter was earlier based on a threshold of 500,000 cells/ml but lately Hillerton (1999) has suggested that the threshold of 200,000 cells/ml would discriminate better between infected and uninfected quarters. SCC at the quarter or cow level may not always be the best determinator of the mastitis status of a quarter or cow. However, SCC is currently the only parameter that can be interpreted from quarter to bulk tank milk and it is widely used for this purpose and as an indicator of the milk quality.

The objective of the experiment was to evaluate the interrelationship between visual inspection of foremilk, CMT-scoring of foremilk, and the cell count on composite milk.

Material and methods

All quarters of 476 cows from 4 herds milked automatically were sampled at every milking within a 48 hour period. The bulk milk SCC of the 4 herds were 250,000-350,000 cells/ml and at least 5% of the cows were expected to have clinical mastitis. Milk quality inspectors examined the foremilk visually and scored the milk by the California Mastitis Test system (CMT) on a 1-5 scale. The expected cell count of CMT-scores were: 1) 150,000, 2) 150-300,000, 3) 300-800,000, 4) >800,000, and 5) > $3x10^6$ cells/ml. Composite milk of the four quarters was analyzed for somatic cell count (SCC). Totally 2063 cow milkings, 8056 visual inspections of foremilk, and 8059 scores of CMT comprise the dataset.

Proceedings of the 2nd International Symposium on Mastitis and Milk Quality (2001), AABP & NMC, 401-404

Results and discussion

The appearance of the milk was abnormal for 14% of the cows and 4.4% of the quarters. Three percent of quarters with visually normal foremilk had a CMT-score of 5 (Table 1 and Fig. 1) whereas 54% with a CMT-score of 5 appeared normal. Eleven percent of quarters with clots in the foremilk scored a CMT of 1 or 2. Foremilk samples containing blood were almost evenly distributed among CMT-scores and are not included in the calculations of sensitivity and specificity. The sensitivity of quarters with abnormal milk was 0.83 for a CMT-score of 3-5 and the specificity was 0.84 (quarters with normal milk that had CMT-score 1 or 2). The contrary test was quite different and resulted in a sensitivity of 0.18 and a specificity of 0.99 (quarters with low CMT-scores on foremilk are probably do not have clinical mastitis). This is a very high specificity but it highlights that quarters without inflammation (low CMT-score) are likely to have milk of normal appearance. Consequently, if the purpose of the test on foremilk is to point out quarters with clinical mastitis, the appearance of the milk has to be checked. But, if the purpose is to avoid quarters with abnormal foremilk, CMT-scoring is doing a reasonable job.

Table 1. Relationship between visual inspection and CMT-score of foremilk, no. of samples.

Max	CMT 1	CMT 2	CMT 3	CMT 4	CMT 5
Normal	5043	1439	635	359	226
Blood	5	7	4	10	10
Flakes	17	16	23	33	39
Clots	12	11	9	25	146

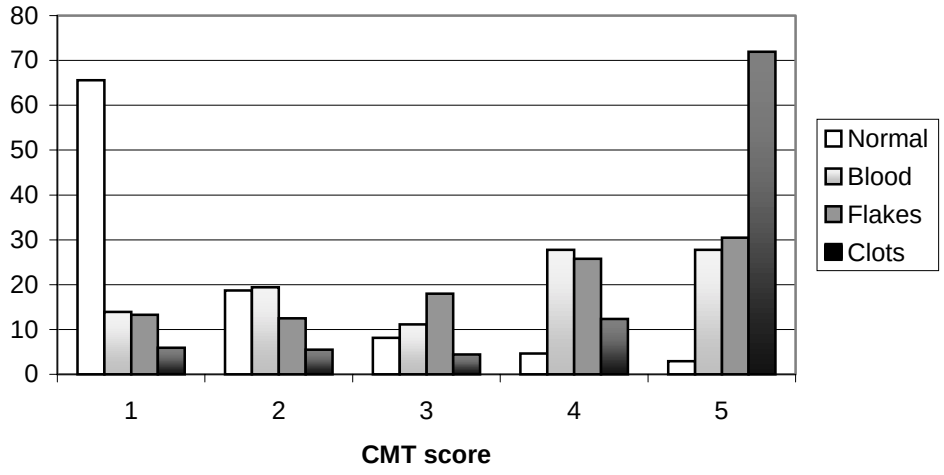

Figure 1. Distribution of CMT-scores of foremilk with normal, blood, thin or flakes, and clots,%.

Cows where all quarters had normal milk had low cell counts in the composite milk and only 3.7% of the samples were $>10^6$ cells/ml (Table 2). Cows that had at least one quarter with clots in the foremilk had a mean SCC of 10^6 cells/ml and 53.8% were $>10^6$ cells/ml. Even when all

quarters had visually normal foremilk 13% of the composite milk samples exceeded 400,000 cells/ml but not all samples were above this threshold if one or more quarters had clots in the foremilk. Cows with blood or flakes in the foremilk had intermediate cell counts in composite milk.

Table 2. Log. SCC of composite milk and percentage of samples > 200,000, 400,000, and 10^6 cells/ml by visual appearance of foremilk (worst quarter).

Worst quarter	No.	Log SCC	SCC > 200, %	SCC > 400, %	SCC > 1000, %
Normal	1761	5.04	25.9	13.0	3.7
Blood	24	5.43	58.3	29.2	8.3
Flakes	102	5.41	54.9	33.3	12.7
Clots	171	6.00	82.5	73.7	53.8

CMT differentiated better between cows with high and low SCC than visual inspection of foremilk. Only 3 (0,25%) of the cow milkings with CMT-scores < 3 in the foremilk had a SCC $>10^6$ cells/ml in composite milk (Table 3) and 23 (2%) were higher than 400,000 cells/ml. Cows with at least one quarter with a CMT-score of 5 had approximately 10^6 cells/ml in average cell count and 45.4% of the composite milk samples exceeded the million. Cows with at least one quarter with a CMT-score of 5 were most likely to have a SCC above 200,000 cells/ml and be mastitic according to the definition of Hillerton (1999).

Table 3. Log. SCC of composite milk and percentage of samples > 200,000, 400,000, and 10^6 cells/ml by CMT-score of foremilk (worst quarter).

Max	No.	Log SCC	SCC > 200, %	SCC > 400, %	SCC > 1000, %
CMT 1	678	4.71	4.7	1.8	0.3
CMT 2	502	4.97	12.4	2.2	0.2
CMT 3	312	5.24	40.0	16.0	2.2
CMT 4	248	5.48	66.5	34.7	7.3
CMT 5	317	5.97	89.0	74.4	45.4

Automatic milking systems are able to retain information about previous milkings and sorting of milk could be dependent on historic information. SCC were slightly lower if two consecutive milkings had visually normal foremilk compared to scoring at a single milking and it also resulted in fewer samples with high SCC (Table 4).

Table 4. Log. SCC of composite milk and percentage of samples > 200,000, 400,000, and 10^6 cells/ml by visual appearance of foremilk of the actual and previous milking (worst quarter).

Previous	Actual	No.	Log SCC	SCC > 200, %	SCC > 400, %	SCC > 1000, %
Normal	Normal	1264	5.00	23.2	10.5	2.5
Abnormal	Normal	101	5.50	58.4	37.6	20.8
Normal	Abnormal	114	5.57	64.0	45.6	23.7
Abnormal	Abnormal	101	6.04	85.1	74.3	55.4

Hillerton (1999) suggests that milk quality is acceptable if < 10% of the cows have SCC between 200-400.000 cells/ml and none above this level. This is not achievable by discarding milk of cows with visually abnormal foremilk even if consecutive milkings are taken into account (Table 2 and 4). It is necessary to perform tests on foremilk more directly associated with SCC on composite milk if milk from cows with SCC > 400,00 cells/ml is undesirable.

The question arises if SCC < 400,000 cells/ml of composite milk is a better discriminator of infected cows than the evaluation of foremilk? About 50% of cows with abnormal foremilk had a composite SCC < 400,000 cells/ml but 13% of cows with normal foremilk had a composite SCC above this level (Table 2) and this threshold by itself would not assure that cows with clinical signs do not deliver milk for consumption. The appearance of the foremilk or a better CMT-score of foremilk is more likely to discriminate between healthy and mastitis cows than the composite SCC. Milk from cows with consecutively low CMT-scores on foremilk only seldom exceeds high SCC (Table 5).

Table 5. Log. SCC of composite milk and percentage of samples > 200,000, 400,000, and 10^6 cells/ml by CMT-score of foremilk of the actual and previous milking (worst quarter).

Previous	Actual	No.	Log SCC	SCC > 200, %	SCC > 400, %	SCC > 1000, %
CMT 1-3	CMT 1-3	983	4.86	11.7	3.6	0.1
CMT 3-5	CMT 1-3 [a]	132	5.18	34.2	13.7	4.3
CMT 1-3	CMT 3-5 [b]	117	5.45	56.8	28.0	12.9
CMT 4-5	CMT 4-5	319	5.83	83.3	63.3	35.1

[a] Actual milking at least 2 CMT-scores lower than last milking

[b] Actual milking at least 2 CMT-scores higher than last milking

Conclusion

CMT-score of foremilk differentiated better between cows with high and low SCC in composite milk than visual inspection of foremilk. Measurement of SCC on composite milk only and discarding milk above certain thresholds will not ensure that all cows with clinically abnormal foremilk is withheld from delivery. Low thresholds of SCC will reduce the frequency of cows with abnormal milk but increase the discarding of milk from cows with visually normal foremilk.

References

Eberhart, R.J., L.J. Hutchinson, and S.B. Spencer. 1982. Relationships of bulk tank somatic cell counts to prevalence of intra mammary infection and to indices of herd production. J. Food Prot. 45:1125-1128.

Hillerton, J.E. 1999. Redefing mastitis based on somatic cell count. International Dairy Federation, Brussels, Belgium. Bulletin 345/1999, 4-6.

Hillerton, J.E. 2000. Detecting mastitis cow side. Proc. 39th Annual Meeting National Mastitis Council, pp. 48-53.