Screening Tests for Abnormal Milk and Physical Examination of the Udder

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Many tests have been described for use in detecting abnormal milk. These include: black plate or strip cup, catalase test, (modified) Whiteside test, serum albumin, milk chloride, electrical conductivity, California Mastitis Test (CMT), Wisconsin Mastitis Test (WMT), Direct Microscopic Somatic Cell Count (DMSCC) and Electronic Somatic Cell Counts (ESCC).

The black plate or strip cup is practical to screen milk for gross abnormality. This is useful in performing a physical examination of a lactating animal. It is also useful as a preliminary step in the preparation of a cow for milking. When used as a part of milking preparation it can aid in the early detection of clinical mastitis and the segregation of grossly abnormal milk from the milk supply. The black plate is not useful in detecting subclinical infections. It must be remembered that estimates from studies indicate that for each clinical case observed, 15 to 40 other subclinical infections exist in the herd. Clinical cases truly represent "the tip of the iceberg" in assessing mastitis problems.

Subclinical infections are characterized by decreased production by the infected gland. In addition, concentration of milk components changes. Milk fat, casein and lactose are decreased. Milk albumin, somatic cells and milk chloride are increased.

Tests for the detection of changes in milk components allow an estimate of udder infection prevalence in a herd and an estimate of the chance of infection being present in a cow or quarter.

The screening tests for abnormal milk or subclinical infection which are in common use today are the CMT, WMT, DMSCC and ESCC.

The California Mastitis Test (CMT)

The CMT continues to be a useful test for estimating somatic cell concentration in milk. Its use has not been superceded by the increasing development of ESCC.

The CMT was designed originally to be made at the side of the cow. To keep the individual quarter milk samples separate, a white plastic paddle was designed having four shallow cups marked A, B, C, and D. When bucket or tank samples are tested, the four cups are used for four different samples.

It is recommended that 2 ml. of milk, or the amount that will remain in the cup when the paddle is tipped to a near vertical position, be used for each test. To this is added an equal amount of CMT reagent. Too little or too much reagent may give a false report. It is especially important that the amount of milk not exceeded the amount of reagent. Gently rotate the paddle in a circular pattern so that the milk and reagent thoroughly mix and swirl. This requires about 10 seconds at which time the mixture is scored while the paddle is in motion. When scoring is completed, rinse the paddle in clear water and shake off excess moisture. The paddle is again ready for use.

Table 1 explains the scoring system, interpretation and approximate cell concentration by CMT score.

When infection is present, production is reduced. Cell concentrations can be used to estimate production losses. This information can be used to create producer interest in cell tests and mastitis control. *Table 2* shows the estimated production losses for quarter and cows (composite samples) at increasing CMT scores.

The Wisconsin Mastitis Test (WMT)

The WMT Test is still used by regulatory agencies to screen producer bulk tank samples for violative cell concentrations.

The WMT Test is a modification of the CMT Test. Reagent and milk are mixed in a tube. The fluid is drained from the tube. Gel which occurs remains in the tube. The column is measured in mm. Producers should receive a WMT score monthly.

Scores of 8mm. or less should be a goal for all producers. If a producer sample scores in excess of 21 mm, cell concentration must be confirmed by the Health Department laboratory using either the DMSCC or ESCC.

WMT scores may be used to estimate herd infection prevalence and production losses. When using WMT scores to estimate prevalence of infection it is recommended that a 3-6 month average of WMT scores be used.


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***VM/SAC*, vol. 67, no. 10, pp 1135-38, 10/72.

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TABLE 1 Scoring and Interpretation of the CMT

The cell count range for the various reaction scores was originally published in 1956. Subsequent extensive experience has shown that these ranges as originally published are valid. A description of the visible reactions and their interpretations are given in the following table:

Symbol	Suggested meaning	Description of visible reaction	Interpretation
—	Negative	Mixture remains liquid but no evidence of formation of a precipitate.	0-200,000 cells/ml 0-25 percent PMN.
T	Trace	A slight precipitate forms and is seen to best advantage by tipping the paddle back and forth and observing the mixture as it flows over the bottom of the cup. Trace reactions tend to disappear with continued movement of the fluid.	150,000-500,000 cells/ml. 30-40 percent PMN.
1	Weak positive	A distinct precipitate but no tendency toward gel formation. With some milks, the reaction is reversible; with continued movement of the paddle, the precipitate may disappear.	400,000-1,500,000 cells/ml. 40-60 percent PMN.
2	Distinct positive	The mixture thickens immediately with some suggestion of gel formation. As the mixture is swirled, it tends to move in toward the center, leaving the bottom of the outer edge of the cup exposed. When the motion is stopped, the mixture levels out and covers the bottom of the cup.	800,000-5,000,000 cells/ml. 60-70 percent PMN.
3	Strong positive	A gel is formed which causes the surface of the mixture to become convex. Usually there is a central peak which remains projecting above the main mass after the motion of the paddle has been stopped. Viscosity is greatly increased so that there is a tendency for the mass to adhere to the bottom of the cup.	Cell number generally over 5,000,000/m/l.

TABLE 2. CMT Scores and Production

CMT Score	Production Lost	
Neg	Cows	Quarters
T	6.0%	9.0%
1	10.0%	19.5%
2	16.0%	31.8%
3	24.5%	43.4%

Reported in Schalm, et al. Bovine Mastitis (1971)

TABLE 3.

	Bulk	Tank	Milk	CMT	Score
	Negative	Trace	1	2	3
(Approximate WMT:)	<5mm	8mm	10mm	16mm	21+mm
% Distribution of herds	40.2	22.5	21.4	10.6	5.3
Avg. % incidence of Mastitis-Positive Cows	17.8	30.7	39.6	58.5	81.6
Avg. % of Herd Milk Produced by Mastitis-Positive Cows	15.7	27.2	36.3	54.6	81.0
Avg. Daily Pounds of Milk Produced/Cow	37.2	35.2	35.0	32.0	29.6
Daily Milk Loss (%/Cow)	0.0	5.4	5.9	14.0	20.4
(Approximate WMT)	5mm	8mm	10mm	16mm	22mm

Adapted from Gray, D. M. and O. W. Schalm: J. Am. Vet. Med. Assoc., 136:195, 1960.

TABLE 4 WMT Scores and Infection Prevalence

WMT Score 3-6 Mo. Avg.	Approximate Infection Prevalence % of Cows In Herd
10 mm.	5%
11 mm.	10%
12 mm.	15%
13 mm.	20%
14 mm.	25%
15 mm.	33%
16 mm.	42%
17 mm. (+)	54%

Crist-Heider et al. JDS 65 828-834 (1982).

The Pasteurized Milk Ordinance (PMO) and The Ohio Revised Code (3701-23-08) stipulate that Grade A Milk may not contain more than 1,500,000 somatic cells per ml. When the WMT score exceeds 21 mm., cell concentration is confirmed by DMSCC or ESCC.

Use of the DMSCC is restricted to use by Health Departments in confirming cell counts on high (21 mm.) WMT samples. It his been used as a research tool. Beyond this, because of technical difficulty, time and cost the DMSCC is not a practical test.

In recent years the development of automated particle counters has led to widespread adoption of ESCC by milk co-operatives and by DHI co-operatives.

The ESCC is provided to producers by Milk Marketing Inc. Counts are conducted weekly but are reported once a month. Studies have not been conducted to show infection prevalence or production relationships but should correlate with CMT and WMT information on these parameters.

The bulk tank ESCC will be affected by the management effort in excluding abnormal milk. For example, a herd in which milk from all clinical cases is excluded from the tank will have a lower ESCC than a herd in which exclusion of abnormal milk is not a consistent practice.

The ESCC will become part of the new component pricing system to be initiated by Milk Marketing Inc. later this year. The new system will pay premiums based on increased protein content and cell count. Cell counts must be below 500,000/ml.

DHI programs in 31 or more states offer some form of somatic cell count or estimate. Most are conducting ESCC. The sample which is collected by the DHI supervisor for butterfat test is used for the ESCC. The most extensive study which demonstrated the usefulness of the ESCC was conducted by Eberhart and others at Penn State University. They demonstrated that when producers received somatic cell counts, subsequent improvement occurred, presumably as a result of adoption of or better attention to mastitis control practices.

The DHI-SCC includes all cows and is not affected by exclusion of cows with clinical cases. However, DHI-SCC or any other estimate of subclinical infection must be considered in conjunction with a knowledge of clinical cases.

It has been suggested that a reasonable goal is to maintain less than 2% of cows excluded from the milk supply. For mastitis control program evaluation, such exclusion would include cows with clinical mastitis or those recently treated with antibiotics for mastitis.

It seems desirable and possible to establish an SCC goal of 200,000/ml. or less. Newer information on production and cow cell counts indicates that major production differences can be demonstrated with changes in cell count at low ranges. Some of the production-cell count relationship may be a result of dilution of cells with high production. Even if this is true, it does not diminish the value of setting a low goal.

Ohio Ag Services is the dairyman-owned cooperative that administers the DHI program in Ohio. In January of this year, they instituted some changes in their SCC program. Most report sheets will show individual cow SCC scores every month. Some of the report sheets will also use a code. *Table 5* shows the code—SCC values and production changes with increasing score.

TABLE 5. Ohio DHI — SCC Codes

Code	Cell Count $n \times 10^3$	Production Changes Pounds per lactation
0	0-18	—400
1	19-35	—400
2	36-71	—400
3	72-141	—400
4	142-238	—400
5	284-565	—400
6	566-1130	—400
7	1131-2262	—400
8	2263-4523	—400
9	4524-(+)	—400

Research is being conducted with other methods of abnormal milk detection. Commercial equipment manufacturers are interested in developing equipment that could automatically detect changes in milk and signal the operator.

When infection occurs, milk chloride increases and conductivity increases. This can be determined with in-line sensors and the operator signalled. Efforts to develop this equipment for twice daily monitoring of udder health assumes that such information will be useful in decision making. It could provide a means for early detection of infection. There are statements made to the effect that mastitis should be treated early. However, there is no evidence that it is cost beneficial to treat subclinically infected lactating cows unless the pathogen is known to be *Streptococcus agalactiae*. Owners and managers should be cautious in investing in such equipment, until cost beneficial effects are demonstrated.

Physical Examination

Physical examination of the udder essentially involves three procedures. Examination of the secretion on a black plate. This is useful in identifying clinical quarters.

Palpation of the udder has been advocated by authors of early veterinary texts. Palpation of the udder may reveal indurations indicative of chronic infection. Palpation, used in conjunction with the cow's clinical mastitis history and monthly SCC can be useful in making culling decisions. Such examination may be unnecessary and would seldom constitute the sole reason for decisions in regard to a cow. Relatively new information on effective control measures and useful methods for identifying subclinically infected cows has reduced the need for extensive discussions on detecting clinical evidence of chronic infection.

A third area of concern in regard to udder examination is the teat end appearance. The papillary duct is the primary defense against new infections. Damage of the integrity of the teat end may have an adverse effect on udder health. Certainly, grossly damaged teat ends are more likely to harbor increased numbers of bacteria. The occurrence of increased bacterial contamination at the teat end undoubtedly increases the risk of infection.

The best study on teat end appearance and udder health was conducted by Farnsworth and Sieber at the University of Minnesota. Their observations are presented in the following *Tables 6 and 7.* The effect of teat disinfection (teat dipping) on teats by appearance is shown in *Table 8.*

Teat end lesions occur due to several reasons. These include chemical irritation, high vacuum, faulty pulsation and cold temperature. Probably other reasons are as yet undetected. However, eliminating any of the predisposing causes listed may lead to improvement. One point that is clear from the Minnesota studies cited is that to some degree teat end appearance was affected by production. In their classification scheme, cows that produced above 76 pounds per day or more had less than 10% teat ends described as normal.

Summary

In summary, the black plate is still a useful tool for the examination of lactating cows to detect clinical mastitis.

The CMT Test is a useful cowside test for detecting subclinical infections.

ESCC provides useful information for assessing the prevalence of subclinical infection and for regular evaluation of mastitis control practices.

Examination of the udder may be indicated. Udder palpation is not as important in the current scheme of management of cows as it may have been in the past but could still provide useful additional indications for culling decisions.

Teat end lesions may be reduced by avoiding chemical irritation and faulty machine function. However, teat end appearance may be related to high production and, depending on degree, is not always an indication of unusual trauma.

TABLE 6 The Prevalence of Teat End Lesions in 22 Non-Problem Herds

Teat End Classification	Number of Teats	Percent of Teats
Normal	762	15.8
Smooth Chronic Rings		
Very Mild	1444	29.9
Mild	1174	24.3
Moderate	349	7.2
Severe	77	1.6
Rough Chronic Rings		
Very Mild	173	3.6
Mild	239	5.0
Moderate	168	3.5
Severe	87	1.8
Acute	16	0.3
Unclassified	335	7.0
Total	4824	100.0

Si eber and Farnsworth. Proc NMC 1980 pg. 1.

TABLE 7 Total Number of Quarters and Percentage of Infected Quarter For Each Teat End Classification.

Classification	% Infected	Total No.
Normal	30.9	554
Smooth Chronic Rings		
Very Mild	24.8	1177
Mild	22.4	1003
Moderate	26.6	312
Severe	34.7	72
Rough Chronic Rings		
Very Mild	20.8	125
Mild	26.1	199
Moderate	32.5	151
Severe	26.2	80
Acute	43.8	16
Unclassified		293
Traumatized	60.9	
Leakers	41.6	

Farnsworth and Sieber. Proc NMC 1980 pg. 12

TABLE 8 Number of New Infection Per 100 Quarters Per Month For Various Teat End Classification.

	N Quarter	Side	Staph. aureus	Strep. ag	Non-ag Strep.	Staph. Epi	Coliform	Total
Normal	34	dipped	0.9	4.7	4.6	1.6	0.0	11.8
	34	control	0.0	2.8	6.5	3.6	1.2	14.1
Smooth	235	dipped	1.2	1.6	2.0	2.2	0.2	7.2
	266	control	1.1	1.7	2.2	3.6	1.3	9.9
Rough	32	dipped	1.2	.5	3.5	2.7	0.1	8.0
	17	control	.9	.5	1.5	4.4	1.1	8.4
Acute	8	dipped	0.0	8.3	1.3	1.3	0.0	10.9
	12	control	4.9	3.3	4.5	3.2	1.5	17.4

Farnsworth and Seiber., Proc. NMC 1980, pg. 12