

**39TH ANNUAL MEETING**  
**NATIONAL MASTITIS COUNCIL, INC.**



**ATLANTA, GEORGIA**  
**SHERATON ATLANTA**  
**FEBRUARY 13-16, 2000**



**NATIONAL MASTITIS COUNCIL, INC.**  
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**NATIONAL MASTITIS COUNCIL**  
**MISSION STATEMENT**

Provide a forum for education and global exchange of information on milk quality, mastitis and relevant research.

Communicate that information to the dairy industry enabling it to control mastitis and improve milk quality.

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*This proceedings includes papers presented at the National Mastitis Council 39th Annual Meeting, February 13-16, 2000, Atlanta, Georgia. These papers report research results and/or opinions of the authors. Publication of this information does not imply endorsement of the contents by the National Mastitis Council. Papers may be reproduced for educational purposes provided credit is given to the authors and the Council.*

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## PRESIDENT'S REPORT

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I am very pleased to welcome you to the 39<sup>th</sup> Annual Meeting of the National Mastitis Council. As we complete our fourth decade of service to the dairy industry and enter the new millennium, we all can be proud of the leadership and the achievements of the National Mastitis Council since its inception in 1961. But we are not done yet. In fact, we are just beginning.

This past year, your Board of Directors approved new vision and mission statements. Our vision: To become a global source for the production of quality milk. Our mission: To provide a forum for the global exchange of information on milk quality, mastitis and relevant research and to communicate that information to the dairy industry enabling it to reduce mastitis and improve milk quality.

These are not mere words. The Council, through its committees, is and has been reaching out to a global dairy industry, hungry for information to improve milk quality worldwide. This past summer, we held our Regional Meeting in Waterloo, Ontario, in conjunction with the Ontario Large Herd Operators. The meeting was a stunning success, with some 350 Canadian and U.S. producers and milk quality specialists in attendance. At this year's Annual Meeting, our program committee included speakers not only from the U.S., but Canada, Denmark, England and the Netherlands. NMC has also licensed Utet Periodic Scientifici srl to translate *Current Concepts of Bovine Mastitis* into Italian. One hour from now, the NMC will also elect its first non-U.S. president, Ann Godkin, from Guelph, Ontario. Having served with Ann on NMC's officer team and Executive Committee for the past several years, I can assure you that you can make no finer choice in your selection of Ann as NMC's first international president.

NMC has accomplished much this past year. Our publication of the revised edition of the *Laboratory Handbook on Bovine Mastitis* was released this past summer. It has already sold more than 400 copies, generating more than \$40,000 in sales. These dollars are extremely important to NMC's finances. Of more importance, however, is the fact that the information contained in the handbook is now being put to use in hundreds of labs to solve milk quality problems around the world. The Council owes a debt of gratitude to the writing committee, led by Joe Hogan, and to Anne Saeman, our Executive Director, for production of the handbook.

NMC's Long Range Planning Committee, under Terry Mitchell's leadership, continues its work. A survey of veterinarians was just completed which will allow NMC to better serve veterinarian information needs regarding milk quality. Our next challenge will be to respond to those needs.

Your Board also agreed this past year to assume management of the National Dairy Quality Awards (NDQA) program in 2000. Started six years ago by Dairy Today magazine, the NDQA program recognizes the very best dairy operations for the production of quality milk in the U.S. Speaking as editor of Dairy Today, I feel it is very appropriate that the National Mastitis Council becomes the official home of this program. Dairy Today, along with the National Milk Producers Federation, World Dairy Expo and corporate sponsors, will continue to provide support for the program. But NMC will now spearhead the effort to continue to grow the program and provide much deserved recognition to dairy farmers for producing high quality milk.

This past year, however, was not without its challenges. As you all know, the National Mastitis Council submitted a proposal to the National Conference on Interstate Milk Shipments this past May to lower the U.S. legal limit of somatic cell counts in Grade A milk to from 750,000 to 400,000 cells/ml. While this proposal was not without controversy, it did receive overwhelming support by your Board of Directors. In my opinion, the proposal was a very reasonable approach to bringing the U.S. dairy industry up to world milk quality standards. Anyone who argues that milk containing 750,000 cells/ml meets the standard of a quality product is simply not paying attention. NMC members owe K. Larry Smith, with the Ohio State University, a huge debt of thanks for spearheading the NCIMS effort. NMC ran into powerful, formidable foes with this proposal. While we failed to achieve passage, I am confident that NMC will ultimately prevail and that we will lead the dairy industry into the 21<sup>st</sup> Century.

Finally, let me thank several individuals for their help this past year. I want to thank all of you who serve on committees, serve as committee chairs and as members of our Board and Executive Committee. I know the time commitment required by this involvement, and you are to be commended for your efforts. I'd also like to thank Gary Heinrich, your Second Vice President, for his help and support this year and for chairing the Short Courses at this meeting. I want to specifically thank First Vice President Ann Godkin, who took on the daunting task of chairing the Program Committee for both the Regional Meeting and this Annual Meeting. Anne Saeman also deserves special thanks for all that she does for the Council. Without her commitment and organizational skills, NMC would not be poised to fulfill our global vision and mission.

In conclusion, let me thank all of you for allowing me to serve as your President. The National Mastitis Council has built a tremendous record of service to the dairy industry. I very much appreciate the opportunity you have given me to be a part of that legacy. But simply remember this, we're not done yet!

## DETECTING MASTITIS COW-SIDE

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The most important practical concern on mastitis is to prevent it happening. Assuming that there has been a failure to prevent invasion of the mammary gland by bacteria and an infection has occurred then it is prudent to know of this. What needs to be known, and when, becomes a matter of relative urgency, investment and purpose.

The milker and manager will want to know about udder health if it affects milk quality, especially when it affects bulk tank value, when it affects the performance of the cow, the parlor and the herd. They also need to know if there is a good chance that a response can restore the status quo. Usually there is only extreme urgency to know about grossly abnormal milk – the clinical case of mastitis. It may be useful to know of pre clinical conditions if bulk tank quality is affected and early detection can be profitable. There is usually little need to know immediately of low grade new infections. That information can be gathered in due course.

Clinical mastitis has become a relatively rare event. The incidence in developed dairy industries is probably 20-40 cases/ 100 cows/year depending on season and location. When milking cows twice daily for 305 days each lactation, that means a case every 6000-12000 quarter milkings or in a family herd of 65 cows one or two cases a month. There may be many more infections, measurements by bacteriology and cell count suggest at least twice as many infections occur as clinical mastitis cases result. Detection of the abnormal is then a matter of concentration on the job, methods, perhaps luck and certainly technique. It must also be influenced by the degree of change in the milk, the severity of the clinical signs, and so is also influenced by interpretation. The threshold has traditionally been when milk becomes significantly abnormal. It is becoming clear from field studies that identification of this varies greatly, especially with the incentive and commitment of the milker to take action. When herd emphasis, purchaser demand and legislative requirements are for quality, low bacterial content and few leukocytes, then mastitis has to be recognised speedily, action e.g. treatment, must be taken quickly, and the fact recorded. At the opposite extreme is the type of herd where, for the less severe mastitis cases, the usual response is not to intervene, Then concentration on detection is less and recording of mastitis less frequent. More mastitis occurs on farms where staff are interested in milk quality and are prepared to treat disease.

### Traditional Detection Methods

The time served methods rely on the quality of the milker and animal husbandry. These involve use of eyes, hands, ears, taste, smell and memory.

Memory - knowing the cow's behavior and attitude in the milking parlor

|       |                                                                                                     |
|-------|-----------------------------------------------------------------------------------------------------|
| Smell | - occasionally used to detect purulent odors                                                        |
| Taste | - many older milkers still taste milk, if suspicious, to determine if it is 'salty'                 |
| Ears  | - used to assist when the cow is in discomfort or pain                                              |
| Hands | - frequently used to assess pain, swelling and local temperature                                    |
| Eyes  | - first information about the cow, the udder and the normality of the milk, its color and integrity |

The sensitivity of these methods varies with the skill of the milker and the severity of the case but have been reported in field studies to average as high as 80% at a single milking (Dodd *et al.*, 1969). Therefore, all cases should be detected if signs persist for 3 milkings. Increasingly the growth of herd size and the pressure for increased, and cost effective, performance has reduced the time that a milker spends with each cow. In many cases time is saved from less pre-milking attention, little udder preparation and no fore milking. Observation is often not easy in some parlor conformations, especially in parallel parlors or swing-over types, and when there is a high cow/milker ratio, a high milk production rate, often in rotary parlors.

### Simple Detection Aids

The first method available when milkers stopped milking into a bucket was provision of the strip cup to examine fore milk. This is probably the gold standard method as milk from each quarter of each cow can be examined. It takes effort and time. The need to save time led to introduction of in-line filters. These are useful if the milker bothers to look at them but are a hindsight source of information in direct-to-line milking parlors. The least immediate detection aids are the milk sock and the bulk tank analysis.

### Indirect Detection Aids

There are a variety of these aids. They vary in their sensitivity and specificity but often more importantly in the immediacy with which information is provided. Most are useful in supplying supportive data but are not suitable at the current stage of development of sensors for wholesale screening.

*Milk cell count* provides one of the most useful indicators of inflammation but measuring is a laboratory procedure at present. The less sensitive *California Mastitis Test* is a work horse cow-side method but not a primary test and it is time intensive for any form of routine use. *NAGase* (N-acetyl glucosaminidase) activity is related to inflammation and may be discriminatory between 'major' and 'minor' pathogens but it is not applicable at cow-side at present and basic determinatory parameters are lacking. Milk composition, especially *lactose* content is indicative of disturbed secretion but is not measurable cow-side at present. Various whey fraction proteins, especially acute phase proteins, change during the pathogenesis of mastitis and appear a sensitive indicator but they are not easily measurable cow-side (at present). The truly confirmatory test would be to detect *bacteria* or their products in milk cow-side. In principal this should be possible e.g. by use of detection antibodies but practice has made this difficult so far because of limits to sensitivity and time to complete the test. One test

for Gram negative bacteria used to a limited extent has a predictive value of 70% (Waage *et al.*, 1994). At best it appears a secondary or confirmatory assay.

The most successful methods have been physical changes in milk measured by simple sensors. It is easy to measure *temperature*, *selected ions* or milk electrical *conductivity*. Tests to do this have been a regular feature of the mastitis literature for 60 years. Availability of practical systems has been more limited and is more recent. Devices are now available that give data in real time but they often give too much data and sensible information is difficult to discern.

### Cow-Side Testing in Real-Time

Early tests at cow-side in the 1940s were still indirect and used a rapid analysis of milk. The most useful was measurement of chloride ions until it was shown that directly measuring the electrical conductivity of milk was as accurate and as well correlated with milk cell count as concentration of any ion (Malcolm *et al.*, 1942).

The major problems with these systems were the speed of use, the number of samples that could be handled, and what to do with the absolute measurements obtained. The whole process was useful only as a scientific tool until the first forms of automation and electronics became available. Single numbers then became available for single milk samples. Converting these data into information has required many more developments. The principal advances have followed automatic collection of data and use of algorithms to produce information. The main problems have been in calculating useful data from continuous measuring and separating real events from the natural variance in the data. The effectiveness of any system is in the sensitivity and specificity with which the data describe an event.

In reality, there is little to choose in sensitivity between the traditional and the best automated systems for detecting clinical mastitis (Table 1). The specificity of detection varies with the definition of the event. This should be relatively easy for clinical mastitis. Visual inspection allows a specificity of 100%, there are clots or there are no clots. Yet the sensitivity is only 80% because errors in sampling and operation come into play. Other detection systems have to match these levels in performance. Practically they have to achieve these levels cost-effectively. The balance is in the comparison between staff effort for inspection of foremilk versus the cost of the system replacing that time.

### Current Automated Systems

Most sophisticated parlors installed in the last 5 years have electronic data collection and management systems. Very useful data can be obtained and it has been shown how valuable these systems may be in monitoring herd and management performance (Stewart *et al.*, 1999). All of the systems use milk electrical conductivity for various purposes. It is a tested method for yield and flow determination but has been less well accepted as an indicator of milk quality. Part of the problem is in the additional use of the primary signal. The main problems have been in the use of relative measurements and making convincing information of clear

purpose available to the user. Some studies have been reported to start to remedy this problem (Milner *et al.*, 1997; Hillerton & Semmens, 1999).

Automated systems collect nearly continuous electrical conductivity data but unfortunately in parlor systems measurements are usually of whole udder milk thus the sensitivity of any happening at the individual quarter is immediately reduced. Data are further reduced in accuracy by selection of one or a few values based on averages or peaks of signal often over a whole milking. The value obtained is then compared with historical data but usually over 10 previous milkings or days. This lead to a further loss of sensitivity from ignoring diurnal events. The historical time scale may rarely reflect the pathogenesis of infection.

Most systems also use other data. Milk temperature is frequently included and a rise greater than 0.5°C occurs in some 50% of cases of clinical mastitis. Yield is often used but a sufficient drop in whole udder yield may not be easily discernible against the background variance. Information is provided from use of algorithms comparing the data obtained with historical and possible herd averages. There are simple flaws in these systems, some inherent to parlor milking, and others from a lack of attention to physiology. Diurnal effects are usually ignored even though yield is very much affected by milking interval, and this may also occur even with 12-hour intervals. No account is taken of the pathogenesis of infection. The timing of events is important in the averaging period, too long a time reduces the sensitivity. Thresholds for changes have to be higher to cope, thus increasing the likelihood of false negative results. The main disadvantage is from measuring pooled milk.

Table 1 Comparison of performance between manual and automated cow-side tests.

|                          |   | <u>% sensitivity</u> | <u>% specificity</u> | <u>Speed</u> | <u>Effort</u>   |
|--------------------------|---|----------------------|----------------------|--------------|-----------------|
| <u>Manual</u>            |   |                      |                      |              |                 |
| Milk/cows inspection     |   | 80                   | 100                  | immediate    | 30s/cow         |
| CMT                      |   | 80                   | ?                    | immediate    | 30s/cow         |
| NAGase                   |   | 60                   | ?                    | laboratory   | minutes - hours |
| Conductivity - hand held |   | 70-100               | 95                   | immediate    | 30s/cow         |
| Bacteriology-culture     |   | 70-80                | ~100                 | > 18h        | significant     |
| Bacteriology - Limulus   | - | 63                   | 97                   | cow-side     | ?               |
| Temperature milk         | - | 50                   | 70                   | immediate    | 0               |
| Yield - manual           |   | 20-40                | low                  | immediate    | 0               |

(continued)

|                   | <u>% sensitivity</u> | <u>% specificity</u> | <u>Speed</u> | <u>Effort</u> |
|-------------------|----------------------|----------------------|--------------|---------------|
| <u>Automatic</u>  |                      |                      |              |               |
| Conductivity      | 70-80                |                      | immediate    | 0             |
| Temperature       | 50                   | 70                   | immediate    | 0             |
| milk              |                      |                      |              |               |
| Yield             | 20-40                | low                  | immediate    | 0             |
| EC + temp + yield | 85-90                | 95                   | immediate    | 0             |

There are at least two practical systems available using quarter milk electrical conductivity data and applying a better algorithm to the data could give useful information. A minimum of 80% predictivity for clinical mastitis has been achieved experimentally using an algorithm combining temperature and time of day production directly with a running average conductivity for the target quarter and a relative conductivity between quarters. Including animal activity also allows these algorithms to be applied to predict estrus and lameness. The important difference here is not in detecting clinical mastitis when disease is apparent but in identifying a pre clinical quarter.

### Automated Milking Systems

The most immediate need for application of mastitis detection and prediction systems, giving reliable information in real-time, is in the fully automated milking systems (robotic milking). These have no direct human supervision yet there is a statutory requirement to detect cows with clinical mastitis and to reject all abnormal milk. At present the attitude of regulatory bodies, and some milk buyers, is that systems should be absolute and detect abnormal milk with 100% sensitivity and 100% specificity. This is unrealistic given that the gold standard of human observation using fore milking only detects 80% of cases. The data available suggest that the better automated systems, using quarter sampling of milk electrical conductivity, milk temperature and production with the best algorithms, achieve at least the same accuracy that a human milker can manage. There is still scope for improvement and the most useful may be in prediction of clinical mastitis for which these systems already show benefit, and coupling of other cow-side tests to allow diagnosis of the infection.

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