Mastitis Control– Where Do We Stand?

by
**John C. Dahl, D.V.M.*
Clintonville, Wisconsin

There has never really been any question whether or not mastitis was essentially a bacterial disease. The question has largely been how do the organisms gain entrance–and become established, in the gland.

We have always had hygiene programs and these efforts have had various results over the years. About ten years ago the "California Mastitis Team" introduced a concept of the related involvement of the milking machine to mastitis. As a result of their efforts, several valuable tools were added to the armament of the clinician:

1. The California Mastitis Test
2. Milk production graphs
3. Pulsator recorder
4. Vacuum stability gauge
5. Air flow meter

The California Mastitis test–with reasonable accuracy, determined leukocyte levels in a test that could be conducted at the side of the cow. It was not only a diagnostic aid, but of communicative assistance also. Here, the extent of the abnormal nature of the secretion could be made visible to the dairyman. Culturing milk samples positive to the C.M.T. was a logical second step in diagnosis. The results of these diagnostic procedures could then be added to milk production graphs, and the losses in milk production determined graphically.

The **pulsator recorder, vacuum stability gauge** and **air flow meter** were described for our specific benefit in a series of articles which appeared in Modern Veterinary Practice in 1960. The author was Mr. Dan Noorlander, a former member of the California team. Dan Noorlander had years of experience working with large dairy operations and was well aware of the necessity of good understanding of a problem before any measure of resolution could be undertaken.

The C.M.T. and the milk production graphs were two of the tools he helped develop with that intent–

1. diagnosis
2. communication

The above referred instruments similarly fill that role.

In the course of the last ten years, the principles of milking machine operation and possible relationships of the milking machine to mastitis have been sufficiently observed clinically to have evoked minimum requirements in nearly every major milk market in America.

So, Where do we stand now?

"Mastitis is a complex." No argument is precipitated by such a statement. It's a complex involving:

1. bacteriology
2. physiology
3. physics

Towering over these three areas is the great intangible–management! Let's just consider the bacteriology, physiology and physics that management contends with.

The "Partial Hygiene" Program

In current vogue is the "partial hygiene" program which gained impetus through the efforts of the dairy researchers at Reading, England. This program is thoroughly discussed in a recent article, "Concepts and Recent Developments in Mastitis Control" which appeared in the July 15, 1969, AVMA Journal. Briefly, partial hygiene is an effort for minimizing the transfer of mastitis organisms from diseased to healthy udders and includes:

1. disinfection of milkers' hands
2. udder washing and disinfection
3. disinfection of teat cups
4. teat dipping after milking

Originally, the English workers were following a "total

**Dr. Dahl is a general practitioner; member of the four man AVMA Mastitis Committee and chairman, Wisconsin VMA Mastitis Committee.*

hygiene" program which included sterilization of the teat cups between cows. They were pasteurizing the cups–180° F. for 15 seconds, but found this step awkward and destructive to the rubber. Now, there is no sanitation of the cups–thus, the "partial hygiene" program.

"Back Flushing"

Most recently, Dan Noorlander and his associates in the South West Milk Quality Council have introduced a "back flushing" device to the market. Between cows, a sanitizing solution is admitted into the claw and discharged through the mouth part of the inflations. By "back flushing" the sanitizer is brought into contact with all surfaces contaminated during each milking act which could serve as a subsequent source of bacterial contamination. At the 1969 meeting of the National Mastitis Council, Dr. W. G. Whittlestone emphasized the value of this procedure, if full coverage of all surfaces could be achieved and the life of the rubber maintained. The industry is apparently moving to accomplish this.

This is an obvious effort to reduce the inoculums of bacteria in the environment of the teat. We'll certainly never achieve a sterile environment. Never, that is–as long as they keep building cows the way they do–with the rectum in such close proximity to the udder! But sanitation remains worthy of our very best efforts.

An interesting awareness at this point in time, is that being given to the flora of the teat canal. Almost all intramammary infections are believed to occur by organisms gaining access to the gland via invasion of the teat canal. The invasiveness of an organism is in part determined by the length of time required to traverse this one half inch of tissue. A generalization places this travel time at about two weeks. An additional factor to the bacteriology then, becomes the physiology of the teat orifice and sphincter muscle.

Dr. D. S. M. Phillips of New Zealand's Ruakura Research Station recently described the efficacy of proper preparation of the cow for milk let-down. In particular, he was emphasizing proper fore stripping of the quarters. His observations were reported recently in "Hoard's Dairyman":

Actually, the logic that led Phillips to his conclusion and proof is quite simple. Before milking, massage and careless stripping can move infected milk up from the bottom of the teat sinus, through the annular ring, and into the udder cistern. There, the organisms enter the fine udder tissues and set up an infection.

A little over 10 years ago, research at Ruakura showed that the quick, "snappy" squeeze action in many milking machine pulsators could cause a violent ejection of milk from the teat upward to the lower cistern. This, wrote Phillips in 1958, provided "a possible mechanism allowing transport of organisms from the lower part of the udder to the fine ducts of the secretory system."

Continuing research, in New Zealand, Australia, England and Canada, supported the view that infection could enter the streak canal during milking. Depending on the action of the milking machine, the teat end, canal, teat sinus, or udder cistern might become infected.

Most likely, however, the main point of deposit of organisms would be the teat end and in the canal. Since the canal is relaxed and more open after milking, organisms on the teat end can infect the canal and the lower part of the teat sinus. **This is why so many researchers and farmers are showing that dipping of the teat end after milking brings about a drop in new infection rates.**

Recently, Phillips paid a working visit to Moorpark Agricultural Research Institute in Eire. There he collaborated in experiments showing that mastitis organisms entering the teat through the streak canal could be moved into the main udder cistern by manual or accidental manipulation of the teats. Simply putting exterior upward pressure on the teats resulted in moving the mastitis organisms from the teat sinus to the upper cistern.

This being so, Phillips speculated that farmers who wash and vigorously massage udders before milking might be pushing heavily-infected milk up into the udder. Another possibility is stripping out the foremilk. If the hand does not close off the top of the teat at the annular ring, milk could be forced up into the gland cistern.

Back at Ruakura, Phillips began a series of trials to determine if this was a valid theory and if, by taking special care, it would be possible to prevent milk inside the teat sinus from being forced up into the udder cistern.

These tests showed that mastitis infection could be reduced dramatically in this way, and also that the necessary treatment was very quick and simple.

It consists of simply closing the teat sinus where it enters the udder cistern, by holding each teat between the thumb and forefinger as high up against the udder as possible, and then squirting each teat four times to expel the foremilk while the teat end is held in this way. Infection left on teat end or in streak canal at end of milking can result in large colonies of mastitis-causing bacteria in lower teat sinus. Annular ring should be closed and infected milk stripped *before* massaging to stimulate let-down.

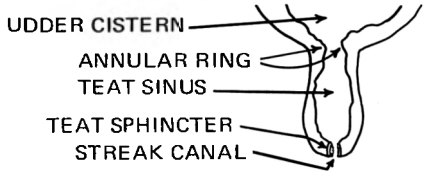


Plate 1.

The trials which demonstrated the value of this procedure were run in four herds. Two teats on each cow were treated; two were used as controls. All the quarters were sampled every two weeks, and tested, using the California Mastitis Test. All positive samples were cultured for pathogenic organisms. The figures in the table show the very great difference between the number of new infections in the treated (new routine) and untreated quarters (old routine).

RESULTS OF NEW METHOD

	Number of quarters with new infections		
IN ONE HERD OF 70 COWS			
1st period (new routine)	3	(old routine)	17
2nd period (old routine)	13	(new routine)	3
3rd period (new routine)	1	(old routine)	5
IN THREE HERDS	NEW ROUTINE		OLD ROUTINE
87 cows	4		28
129 cows	20		47
120 cows	15		41

In the experiment, a new infection was defined as one which was positive to the C.M.T. test and had pathogenic organisms after having had at least two negative tests.

In one herd in the experiment, the treated and untreated quarters were switched around at two-month intervals. Here, the pattern of new infections was strikingly reversed following the change, showing clearly that infections were increased greatly in quarters where conventional washing and stimulation was forcing foremilk up into the main udder cistern. Phillips suggests that a likely sequence of events is: "The entrance to the streak canal becomes contaminated with organisms during milking and, by the time the next milking comes around, these organisms have colonized the streak canal and become established in the lower part of the teat sinus. From there they would be ready for injection into the main udder cistern through the mechanical manipulation of the teats during the premilking washing and stimulus."

Already we have been able to interweave bacteriology, physiology and just a little physics. Let's consider this last aspect in greater detail, especially pressure differentials within the milking system.

Pressure Differentials

The principles of physics relate largely to pressure differentials. Prior to the stimulation for milk let-down, the pressure in the gland is approximately that of atmospheric. After proper stimulation, we build up a pressure of 35-55 mm. Hg (1.5-2.0"). This pressure differential is increased by applying a vacuum below the teat of 312 mm. Hg. (12.5") and is sufficient to overcome the sphincter muscle surrounding the teat canal and enabling the milk to flow from the teat sinus into the liner cavity and milk receptacle–be it claw, breaker cup or bucket.

The important principle–milk moves from the area of highest pressure to the area of lowest pressure–all along the system.

The physiological factor concerned is that of developing sufficient pressures across the teat orifice to open the canal to achieve the rapid evacuation of milk from the gland. However, this cannot be done without regard to the extent to which we dilate the orifice by stretching the sphincter muscle. If we unduly fatigue that muscle by excessive stretching or by congestion, then the teat canal will not close properly with the collapsing phase of the liner. Also, the canal may remain partially open after the end point of milking and when the cow returns to a highly contaminated and hostile environment.

The important principle–two phenomena which should occur simultaneously:

1. closure of teat orifice
2. and liner in massaging phase.

The attempt to enhance the string-like tendency of the sphincter muscle is to assure that even though on occasion the pressure below the teat orifice may exceed the pressure within the gland, the flow cannot proceed into the area of lower pressure because the door has been closed!

Throughout this discussion, I have emphasized that: IN THE MILKING SYSTEM, MILK ALWAYS MOVES FROM THE AREA OF HIGHEST PRESSURE TO THE AREA OF LOWEST PRESSURE.

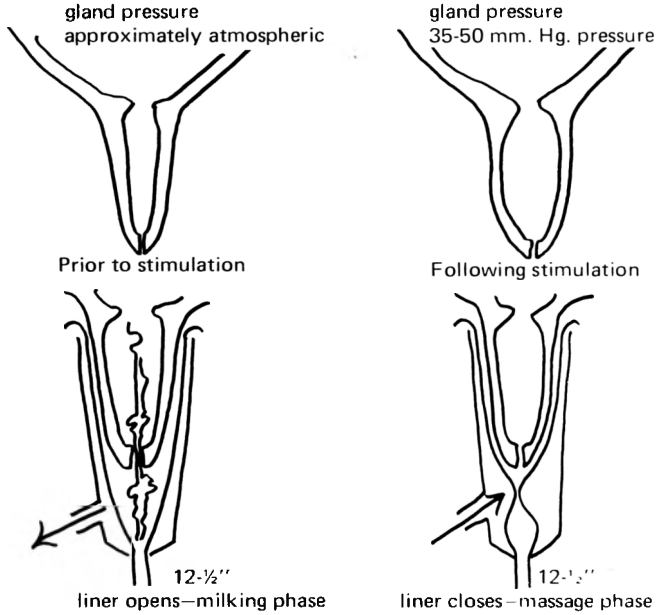
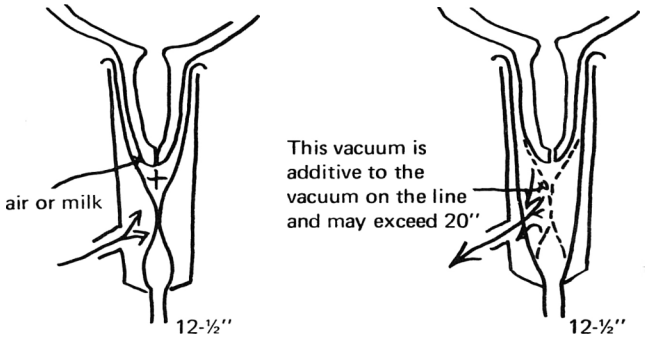


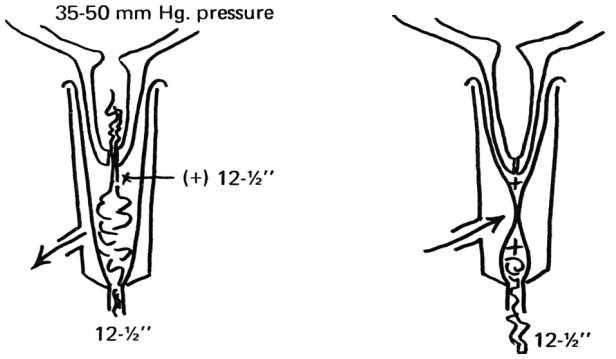
Plate 2.

When the liner compresses, it compresses everything within it.

When the liner opens, it creates a vacuum.



(air=pneumatic pump)
(milk=hydraulic pump)



If the vacuum in the liner cavity is greater than the vacuum in the inflation stem, the milk may be retained within the liner cavity.

Milk retained within the liner cavity during the milking phase is ejected forcibly when the liner closes.

Plate 3.

The pressure created by the liner closing is equal in all directions.

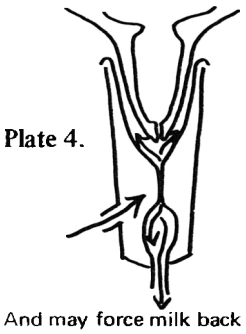
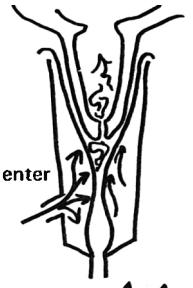
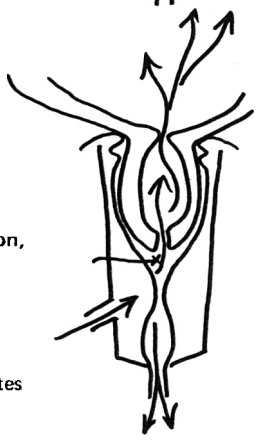


Plate 4.



If the teat orifice is open, flow may enter the teat sinus.



And may force milk back against the teat orifice if there is any obstruction to the free flow of milk and air.

This phenomenon will be exaggerated by:

1. Large bore liners, causing teat to balloon,
2. Widely dilating sphincter,
3. Creating shut off of annular folds,
4. And effecting a high pressure, against a small orifice,
5. Jetting milk to foci high in the gland.
6. Too rapid closing of the liner exaggerates the whole phenomenon.

Similar to the effect of a syringe, the opening phase of the liner may result in milk being returned from the liner cavity or milk stem, against the teat orifice.

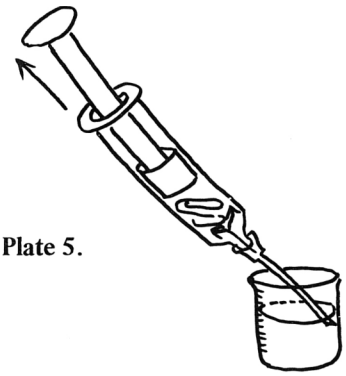
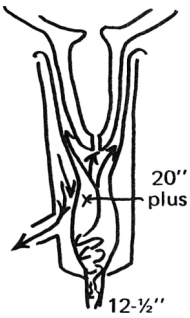


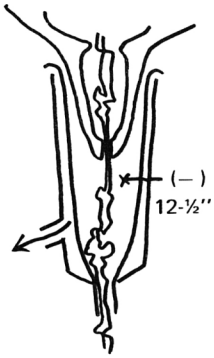
Plate 5.



the speed may exceed 50' per second!

TO AVOID BACK-FLUSHING OF THE TEAT:

Achieve simultaneously:
Closing of the teat sphincter and closing of the liner.
Also:
Avoid excessive pressures below teat orifice.



Avoid flooding liner by excessive vacuum levels within liner cavity.

Therapy

Therapy is certainly an integral part of any mastitis control programming. The English workers are advising the treatment of all dry cows, utilizing semi-synthetic penicillins in slow release bases. Specifically, they refer to benzathine closacillin in aluminum monostearate. This product is not available for veterinary use in this country yet, but on the basis of limited field testing, does suggest a real improvement in therapy, especially when Staphylococci are the causative organisms.

I personally am not yet ready to abandon diagnostic procedures and move to the "every cow, every quarter, dry treatment program." Economics is cited as one of the advantages of dry treatment, but to treat every cow is to overtreat 50% of the individuals and 70% of the quarters. Also, in many instances, early treatment of a milking cow may salvage a lactation.

There is much argument as to whether or not a normal flora of the gland exists. Largely, such discussion is pure semantics. Regardless of definition, a flora can be recovered from many quarters, which exists in a symbiotic relation-

(continued on pg. 9)

cattle. Semen is available in the U.S. from several Simmental bulls in Canada, while some of the first Simmental A.I. calves in the U.S. are now approaching one year of age. The present headquarters of U.S. Simmental associates is in Cairo, Illinois.

A fourth breed which touched the North American shores in the 1968-69 Canadian importation into Grosse Isle is the *Maine-Anjou breed.* These cattle are the second largest breed in the world and are also a dual purpose breed. The breed originated in approximately 1840 by crossing Duram cattle from England on native French cattle. The resulting red and white animals are extremely long, very muscular, with good strength of loin, and long muscles on the rear quarter. Many of the breeders in France will place two or perhaps three calves on one cow and then milk the extra cows. Milk production records are also kept on this breed at the herd book headquarters in Chateau-Gontier. At the present time, there are two yearling males and one yearling female in Canada. Semen is for sale in the United States through at least one A.I. stud. The newly formed Maine-Anjou Society of America has its headquarters in Kansas City and is planning its first annual meeting in December, 1970.

There will undoubtedly be other breeds brought to these shores in future importations in this new quest for genetic material to improve our beef production. Should the present nationwide interest in these various breeds continue for a decade, the result could very well exceed the influence that the Shorthorn bulls had on the Longhorn herds of the early west.

("Mastitis," continued from page 6)

ship with the cow. To knock out this flora, renders the animal subject to an acute infectious process by more pathogenic organisms. It seems to me that this constitutes the greatest danger in the dry cow treatment program. Additionally, concern is evidenced over the likelihood of developing a bacterial population which is resistant to antibiotics; or the introduction of pathogens with the cannula of the therapeutic tube which are refractors to that particular medicament.

It is my judgement that we do not know enough about the long term effect of such a random therapy program to recommend it to our clients at this time.

Very simply, I have been describing the pathogenesis of mastitis. Any steps we can take to interrupt the chain of events helps in the control of this disease complex. Bringing together the present knowledge of bacteriology, physiology and physical principles involved, we should be able to increase the time factor and decrease the number of bacteria traversing that one half inch of tissue separating the external environment from the internal environment of the gland!

"Bovine practice will rise to new horizons of excellence under the stimulus of our organized efforts."

Vernon L. Tharp, D.V.M.
AABP Director, 4th District