BOVINE MASTITIS: ITS DETECTION AND PREVENTION[1, 2]

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"CORONER ACTS TO CURB TOOL OF PENICILLIN – Cites 3 Deaths, Asks Sensitivity tests." This was an actual newspaper headline (*1*). It is estimated that five to six per cent of all individuals are sensitive to some form of penicillin, with 3,000 to 4,000 cases annually of anaphylactoid shock and a mortality rate of ten per cent (*33*). Demonstration of definite penicillin sensitization to humans through contaminated milk has been recorded (*34, 32*). These incidents have created a greater cognizance of the importance of penicillin and other antibiotics in milk utilized for human consumption with the concomitant emphasis on mastitis prevention and therapy (*31*).

WHAT IS MASTITIS?

Mastitis is an inflammation of any part or all of the mammary gland with the cardinal symptoms of heat, redness, swelling, pain, and the abnormal secretion that usually accompanies inflammation of tissue. The presence of an organism within the mammary gland does not in itself constitute mastitis, as most quarters of nearly all mammary glands contain organisms living as commensal parasites (*9, 16, 7*). These organisms are all potential mastitis producing organisms, and will become pathogenic if the mammary gland is subjected to stress and its resistance lowered.

Mastitis differs from many of the infectious diseases of cattle such as tuberculosis, brucellosis, and anthrax in that no one specific organism alone is responsible for the initiation and the production of the symptoms of mastitis. Numerous investigations have been concerned with *Streptococcus agalactiae* as a specific causative agent of mastitis. Confusion has resulted in that inhibitory bacteriological media were utilized to exclude all other organisms, or if other organisms were isolated on a non-inhibitory medium, organisms other than *S. agalactiae* often have been designated as contaminants. The theory that mastitis is the presence within a mammary gland of an organism, with total disregard for clinical symptomatology, has contributed to additional confusion with wide variance in investigational data and conclusions (*3, 14, 19, 21*).

Clinical mastitis may be classified on the basis of pathology and severity. In mild mastitis a few clots appear in the first milk removed. Sometimes there is a slight swelling of the infected quarter and this quarter may have a temperature above normal.

In acute mastitis many clots are formed and the infected quarter has an extensive abnormal secretion. The quarter is swollen, hard and hot. The body temperature is abnormal and the cow may be off feed.

In peracute mastitis all the symptoms of the acute form are exhibited only in a more intense manner. In addition, the animal is usually completely off feed and very depressed. All cows that have mastitis will give less milk, but in a varying degree.

In chronic mastitis intermittent symptoms of any one of the above types may be present.

WHAT ARE THE CAUSATIVE AGENTS OF MASTITIS?

Investigators utilizing non-inhibitory media and isolating organisms from mammary secretions have reported staphylococci as the predominant organism isolated (*2, 4, 6, 17, 18, 20, 22*). Investigations by Krabbenhoft *et al.* (*12*) have corroborated these findings in isolations from mammary secretions of clinical mastitic and nonmastitic glands or quarters (Table 1).

In addition, many other microorganisms and viruses have been isolated from the mammary gland and/or designated as the causative agent of mastitis (Table 2). When consideration is given to the

TABLE 1—DISTRIBUTIONS OF MICROORGANISMS (% DISTRIBUTION) FROM MASTITIC AND NON-MASTITIC QUARTERS

Microorganisms Isolated	Mastitic quarters	Non-mastitic quarters
Micrococcus	62	76
Escherichia and Aerobacter	10	9
Streptococcus	14	3
Proteus	4	1
Corynebacterium	2	4
Bacillus	2	3
Klebsiella	1	0
Gaffkya	0	3
Sarcina	0	2
Diplococcus	2	0

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[2]Presented at the 47th Annual Meeting of the INTERNATIONAL ASSOCIATION of Milk and Food Sanitarians, Inc., at Chicago, Illinois, October 26-28, 1960.

TABLE 2—MICROORGANISMS ISOLATED FROM MASTITIC AND/OR INCRIMINATED AS CAUSATIVE AGENTS OF MASTITIS

Bacteria		Molds And Yeasts
(Gram +)	(Gram −)	*Nocardia*
Staphylococcus	*Pasteurella*	*Candida*
Streptococcus	*Brucella*	*Cryptococcus*
Clostridium	*Klebsiella*	*Blastomyces*
Gaffkya	*Erysipelothrix*	Viruses
Sarcina	*Escherichia*	New Castle Disease
Listeria	*Aerobacter*	Vesicular Stomatitis
Serratia	*Proteus*	Vaccinia
Mycobacterium	*Pseudomonas*	Psittacosis
Corynebacterium	*Leptospira*	Foot and Mouth Disease
		Enteric

multitudinous forms of microbiological life existing in the environment of the bovine, and the anatomical arrangement of the mammary gland, it is readily understandable that the ease of mammary invasion provides extensive variations of intra-mammary microbial life. The intramammary flora of clinical mastitis-free mammary glands deserves greater cognizance. Investigations indicate that the chemotherapeutic removal of one genus usually provides a more suitable environment for other existing organisms, or for the intramammary invasion of organisms existing in the immediate environment that previously have not been present in the mammary gland.

Through various organisms apparently live a parasitic (commensal form) life within the mammary gland, they all possess a pathogenic potentiality that is released upon subjection of the mammary gland to stress. Stress may result from trauma or lowered resistance within the mammary gland with resulting inflammation and abnormal secretions.

How May Mastitis be Detected?

Many tests have been proposed to detect mastitis, through few have withstood the test of time. The strip cup, when used at each milking, has proved one of the most reliable tests available to the dairyman. It provides detection of the early symptoms of mastitis as well as the specific infected quarter. It is a simple, inexpensive, rapid test not requiring the addition of chemicals or stirring.

Laboratory bacteriological examination of milk samples has often been advocated. This method provides information regarding the specific organism present within the mammary gland. If clinical mastitis exists, the time lapse between collection of the milk sample and bacteriological identification is too great to provide information that will contribute to chemotherapy. Thus, by the time identification has been completed, successful therapy will have resulted by "guess" chemotherapy; or the inflammation will have progressed beyond possible successful therapy. When bacteriological examination of milk is utilized in a prevention program, a decision must be made as to which organism will be designated as the causative agent of bovine mastitis. If the designated organism is eliminated, the possibilities of its return or its replacement by even a more virulent type must be considered.

The Whiteside test has been demonstrated to be of value in detecting the existence of mastitis within a herd when carried out on a sample of herd milk from a bulk tank *(10, 26)*. Its use on an individual cow or individual quarter basis has indicated a high incidence of mastitis to exist in herds where little or no clinical mastitis has existed over an extended period of time. Recently, a modification of the Whiteside test (California Mastitis Test) has been proposed for the individual cow and herd detection of mastitis. Investigations indicate that this test, as the Whiteside, is extremely sensitive when employed on a per quarter or cow basis (*8*). Instances of 75% or more of the quarters being positive with no record of clinical mastitis existing for eight months prior to the test and six months following the test have been recorded (*25*).

Bacterial counts have been employed and advocated as indicators of mastitis, but investigations have demonstrated little correlation between bacterial counts and the incidence of mastitis (*30*). Relationship between bacterial counts, dairy equipment sanitation and the cooling process of milk have definitely been demonstrated.

Predisposing Causes of Mastitis

Mastitis can be described as a "do-it-yourself disease of dairy cattle." The necessary tools are found in the tool box "of inefficient management." Prevention is nothing more than the exercising of good management procedures and sane dairy practices that are often ignored or inadequately carried out.

Milking

Milk "let-down" is one of the paramount essentials of good milking. Cows that have been improperly stimulated will not let down their milk, with resulting crawling of teat cups and mammary gland tissue damage. Washing the udder with warm water and massaging are part of the necessary procedures required to induce milk "let-down." Disinfectants in the wash water have not proved to be of value in the prevention or control of mastitis (*5*).

The milking machine always should be kept in maximum operating condition (*15*). The milking machine serviceman can be of inestimable value to the dairyman through routine machine inspection, re-

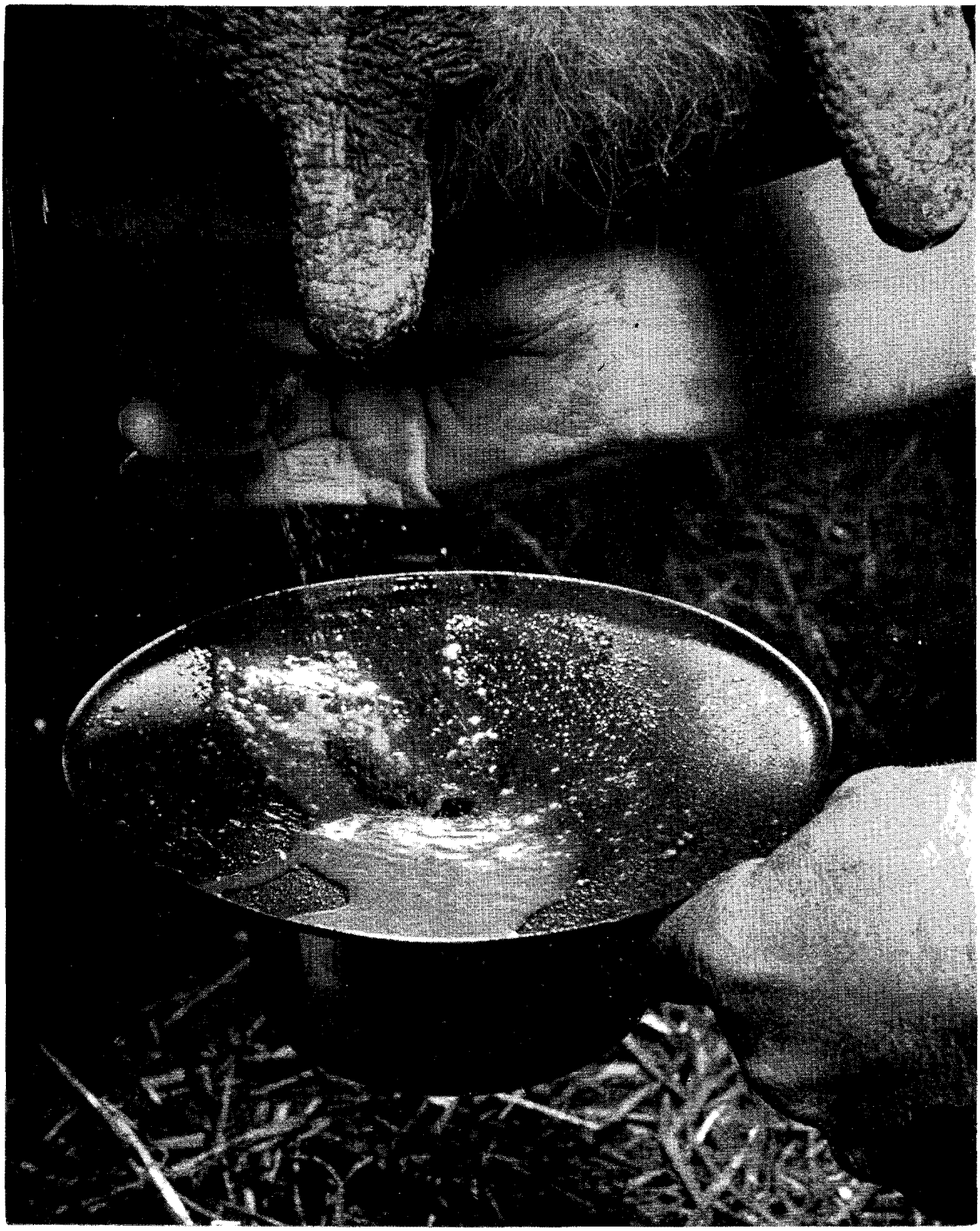

Figure 1. The use of the strip cup at every milking is the best for early detection of mastitis. (Photograph through courtesy of Babson Bros.)

pair and in training the dairyman to correctly use the milking machine.

Though the milking machine has received much blame as the cause of mastitis, the operator is the predominant influencing factor. If the milking procedure is to be adequately carried out, one man should operate no more than two units at any one time. The predominant oversight on the part of the milker is the failure to remove the teat cup when the quarter is dry. All quarters do not milk out at the same time. A good milker knows the variations in the milk-out time of each of the quarters of each of the cows he milks. When the teat cup is not removed from a milked-out quarter, the intramammary vacuum is increased and trauma results, providing the necessary conditions for the initiation of mastitis. When the teat cup is removed, the vacuum should be released before removal to prevent eversion of the teat canal and irritation to the sensitive lining.

Rubber inflations that are cracked or have lost their elasticity and are caked with milk deposits are another predominant cause of mastitis. Two sets of rubber inflations should be used interchangeably for weekly intervals. While not in use, storage in a 5% lye solution prolongs the life and increases the milking efficiency of rubber inflations (*11*). All rubber parts of the milking machine should carefully and frequently be inspected for cracks or leaks, as any alteration in the normal recommended vacuum often contributes to injury of the mammary gland. A milking machine should be operated according to the manufacturer's instructions. The pulsation rate and vacuum, when incorrect, may cause mastitis. It is always a good policy to stop milking with machines when production is below five pounds per milking.

Housing and the Housing Area

Dampness, cold, and drafts are factors of stress to the mammary gland, with mastitis usually following. Cold concrete floors, lack of bedding, open hay or stray chutes, broken windows or doors, and poor ventilation may cause these stresses. The cow should be provided with stall or laying space of adequate size and maximum comfort if injury and stress are to be avoided. Barn yards and pastures that have barbed wire, sharp rocks, and rubbish laying around may cause injury to the mammary gland often associated with mastitis.

Stagnant pools of water frequently contain mastitis-producing organisms and it is not unusual to observe cows standing udder-deep in such pools during hot weather. These pools will not only provide contact with mastitis-producing organisms but cause chapped and irritated teats. The resulting pain during the milking process will cause failure of milk let-down, trauma and mastitis.

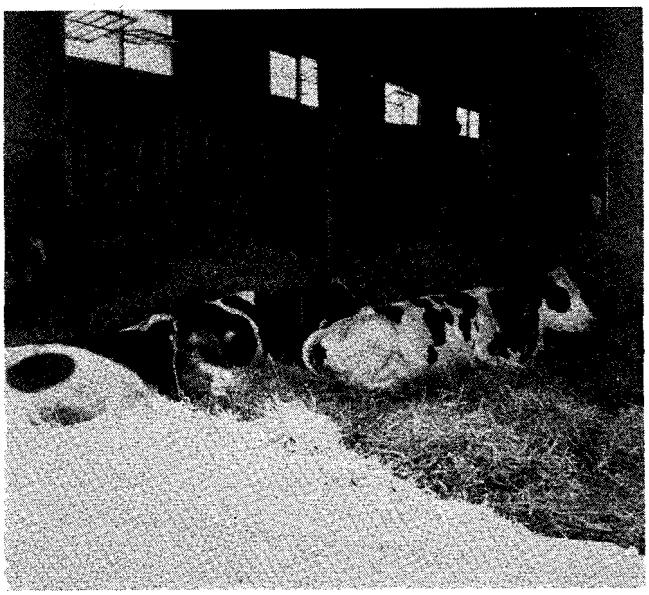

Figure 2. Adequate housing space that is dry, well bedded, and free of drafts is essential in preventing mastitis.

Figure 3. The outlet opening of the automatic barn cleaner may serve as the source of cold draft on udders of stanchioned cows.

Approaches to the milking parlor or the barn should be of cement roughened enough to prevent slipping and designed to provide maximum drainage and to assure the absense of any protruding material that might cause injury to the mammary gland.

Investigations have demonstrated that a simple, sane, well-presented mastitis prevention program (see below) will greatly aid the dairy farmer in preventing mastitis and lower the antibiotic content of milk supplied to the market (*23*) (Table 3). This can be

TABLE 3—FIGURES REPRESENT PERCENTAGE OF HERDS HAVING CLINICAL MASTITIS, AND PERCENTAGE OF BULK MILK SAMPLES CONTAINING ANTIBIOTICS BEFORE AND FOLLOWING PRESENTATION OF MASTITIS PREVENTION PROGRAM OUTLINED IN TEXT

	Clinical mastitis	Antibiotics in bulk samples
November	31.1%	8.1
December	15.0%	
January	34.4	5.4
February	43.5	13.5
	Mastitis meeting with producers prevention program presented	
March	7.3	0.0
April	7.3	0.0
May	5.1	0.0

achieved only when maximum cooperation is obtained by all persons associated with the dairy industry, including the veterinarian, the milk inspector, the milk plant fieldmen, the dairy farmer, the milking machine serviceman, and the dairy extension service.

Inheritance

The possibility of inherited resistance has often been suggested (*13*). Investigations indicate that the most important aspect of the inheritance to mastitis resistance is udder attachment and teat anatomy and placement. Teats from which it is difficult to remove milk or that are attached so as to tend to become horizontal often are on quarters that prove to have mastitis. An extremely large udder with a weak attachment will become pendulous with age and is subject to consistent trauma and/or injury.

VACCINATION

Vaccination with mixed bacterins and toxoids have, at various times, received much attention as a means of mastitis prevention. Though vaccination may be of some benefit, it cannot replace good management and sane dairy practices. A possible reason that vaccines have failed over a period of time has been the attempt by the dairy farmer to replace good management and sane dairy practices with vaccination.

Figure 4. Cows with strongly attached udders usually are less susceptible to udder injury and mastitis.

TREATMENT

The dairyman who devotes full time to mastitis prevention and relies on a competent veterinarian for chemotherapy, when it is required, is usually one who has few veterinary costs and few problems with mastitis.

When mastitis is detected, stimulate the infected quarter for milk let-down and completely milk it out. Repeat this process at hourly intervals at least four to five times. If the inflammation does not appear to be subsiding, a dairyman has but one recourse, and that is to obtain competent veterinary service immediately.

Avoid the use of the highly advertised intramammary medicants. The antibiotic content of these preparations is seldom of sufficient strength to counteract the infection if it were all released from the vehicle and uniformly dispersed throughout the infected quarter. Most of the vehicles of these preparations fail to penetrate the involved mammary area and remain in the lower third of the mammary gland (*24*). Antibiotics remain bound to the vehicle and are not released for distribution throughout the gland, but are milked out in subsequent milking (*28, 29*).

All milk from treated quarters should be discarded for at least 72 hours following administration. Written instructions regarding discarding of milk following treatment should be obtained from the attending veterinarian.

Field investigations have demonstrated that the above mentioned approaches to mastitis are efficacious (*27*).

A SUGGESTED MASTITIS PREVENTION PROGRAM

Inheritance

- Select cows with well attached udders.
- Select rapid, easy milkers.
- Avoid excessively large uddered cows.
- Raise your own replacements.

Housing

- Provide adequate stall or pen space.
- Provide adequate quality bedding.
- Avoid: Dampness, cold, and drafts.
  - Open hay or straw chutes.
  - Broken windows and doors.
- Prevent udder trauma by avoiding:
  - High door sills.
  - Rubbish in yards and pasture.
  - Slippery floors and entrance aprons.

Corn stubble or brush pasture.
Hard driving with dogs.
Flies, mosquitoes.

Dehorn all animals.

Employ correct milking procedures and good milking equipment.

Prevent cow pox.

Prevent sunburned, chapped and/or frozen teats.

Avoid use of irritating disinfectants on cow teats.

Milking

Stimulate milk let-down one minute before attaching machine:

Wash and massage udder with clean warm water.
Use strip cup.

Remove teat cup when milk ceases to flow.

Never milk with more than two units per operator.

Always break vacuum before removing teat cups from teat.

Keep milking machine in maximum operating condition:

Have milking machine checked annually by recognized serviceman.

Learn to recognize defective machine operation and to correct or repair it.

Follow manufacturer's operating instructions for:
Correct pulsation rate.
Recognized vacuum level.

Keep vacuum line clean.

Check and eliminate any vacuum leaks.

Have vacuum regulator and gauges checked annually for proper operation.

Keep rubber inflations clean and replace after 1000 milkings.

Use two sets of rubber inflations — alternate each week.

Obtain competent veterinary service upon detecting first signs of mastitis.

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