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Studies and Observations on Bovine Mastitis

I. Incidence of Mastitis

**Keith T. Maddy, D.V.M.**

While working as Nevada Agricultural Extension Service Veterinarian and as Veterinarian for the Clark County Livestock Improvement Association for a two and one-third year period in southern Nevada, the author tested for and treated thousands of cases of infectious bovine mastitis. This article reports on two sets of investigations on the incidence of mastitis.

The first investigation entailed the use of the Hotis test on five herds of dairy cattle to determine which quarters were probably infected with *Streptococcus agalactiae* and whether or not the incidence of mastitis was correlated with the degree of milking ease.

Three hundred thirty-nine cows were tested, all of which were machine milked. The known infected cows were milked last. The milking machine teat cups were dipped in water and then in 300 p.p.m. chlorine solution between cows.

Composite milk samples were drawn from each cow, just before the regular milking, into a screw cap tube containing the Hotis test solution. The samples were incubated at 37°C for 24 hours. At the end of that time those showing the yellow deposit or colonies in the bottom of the tube or the yellow clumps on the side of the tube were considered positive. Individual quarter samples were drawn from the positive cows. These samples were submitted to the Hotis test and the quarters which gave positive reactions were treated.

In order to check the dairyman’s theory that the harder a cow is to milk the less likely she is to have mastitis, prior to making the first Hotis test each dairyman was asked to classify his cows as easy, average and hard milkers. The results of this survey are shown in Tables 1. One hundred thirteen quarters were diagnosed as infected by *Streptococcus agalactiae*. The infection involved 36.32 percent of the quarters of the easy milking cows; it involved 0.16 percent of the quarters of the average milking cows and 3.75 percent of the quarters of the hard milking cows. It is believed that the larger the teat orifice is, the greater will be the ease for infective bacteria to gain entrance to the udder. When the udder infusion needle was passed through the teat orifice to give the intramammary treatments, the
TABLE I
SUMMARY OF INFECTIONS FOUND IN FIVE HERDS

<table>
<thead>
<tr>
<th>Type of cows as a milker</th>
<th>Number of each class of cows</th>
<th>Percent of each class of cows</th>
<th>Number of cows infected in each class</th>
<th>Number of quarters infected of total of all quarters infected</th>
<th>Percent of quarters infected of all quarters in that group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy</td>
<td>64</td>
<td>18.87%</td>
<td>48</td>
<td>93</td>
<td>82.30%</td>
</tr>
<tr>
<td>Average</td>
<td>255</td>
<td>75.22%</td>
<td>14</td>
<td>17</td>
<td>15.00%</td>
</tr>
<tr>
<td>Hard</td>
<td>20</td>
<td>5.89%</td>
<td>3</td>
<td>3</td>
<td>2.65%</td>
</tr>
<tr>
<td></td>
<td>339</td>
<td>100.00%</td>
<td>65</td>
<td>113</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

sizes of the openings were noted. It was found that the degree of difficulty of passing the needle was closely correlated with the owners' classifications of difficulty of milking.

This survey indicated that S. agalactiae is much more prevalent in the easy milking cows, practically nonexistent in the average milking cows and only a very minor problem in the hard milking cows. The probable reason for the high rate of infection in the easy milking cows is that the teat orifice is large and it is easy for infective bacteria to ascend the teat canal.

A possible reason for the noticeably higher percent of infection in the hard milking cows as compared to the average milking cows is that the milking machines are left on the hard milking cows much longer than on the average cows, and as a result much more irritation and damage to the internal epithelium of the teat is likely. Any type of irritation of the epithelium of the teat, external or internal, is recognized as a predisposing factor to mastitis.

The infected quarters were treated. The report on the treatment results will be found in Article III of this study.

The second investigation involved the bacteriological examination of milk from cows in seven different herds to determine the incidence of infection with the various mastitis-causing bacteria. Exactly 500 cows were tested when the investigation was started.

Hotis samples were collected, incubated for 24 hours and the reactions noted. Smears were made from the milk, Gram stained and examined under the microscope for the presence of bacteria and to determine an approximate leucocyte count. Milk samples showing no bacteria and those showing streptococci, staphylococci or bacteria resembling corynebacteria were plated on oxblood agar. After 24 hours of incubation the colonies were examined and any hemolysis was noted. Beta hemolytic staphylococci were checked for rabbit plasma coagulation, and if positive the organism was called Staphylococcus aureus. Bits of streptococcal colonies were placed in veal infusion broth. Twenty-four hours later carbohydrate media, litmus milk and sodium hippurate broth were inoculated for identification. Corynebacterium pyogenes was tentatively diagnosed by the typical morphology of the organism under the microscope and by the appearance of the colonies on blood agar plates. Definite diagnosis was made according to the biochemical properties of an isolated culture. Coliform bacteria were tentatively identified by the appearance in the Hotis tube of a solid green or yellow coloration of the milk with some gas production and the finding of a gram negative rod on the microscopic smear. Further verification of the presence of coliform organisms was made by plating the suspected organisms on Edward's medium and observing the growth of typical large black colonies.

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Organisms from these colonies were checked for acid and gas reactions with lactose and dextrose. If positive they were checked by the M. R. and V. P. tests— if M. R. positive and V. P. negative they were called *Escherichia* species and if V. P. positive and M. R. negative they were called *Aerobacter* species. Exact specie identification of all infecting organisms was not attempted because of the lack of time, materials and equipment.

**Results**

The results of the tests are shown in Table II. The 500 cows tested were from seven different herds located in various places in the three different isolated irrigated agricultural valleys. These seven herds had had no previous organized mastitis control program but had received a small amount of veterinary treatment and a moderate amount of herdsman treatment with sulfanilamide-in-oil intramammary infusions.

Moderate success with achieved with herdsman compliance in these seven herds with the following mastitis control program:

1. Incurable cows were disposed of.
2. Those cows having chronically recurring attacks of mastitis were milked last.
3. Cases of mastitis were treated as they occurred.
4. A few streams of milk were stripped out into a strip cup from each cow prior to putting on the milking machine to avoid contaminating milk cups with milk from an infected quarter.
5. The udders were washed with warm chlorine solution.
6. The teat cups were dipped in water to rinse off the milk and then set in a 300 p.p.m. chlorine solution for three minutes between cows.
7. The teats were dipped in a small cup of chlorine solution after milking, and the cup thrown away after use on one cow.
8. All cuts, injuries and cowpox on the udders were promptly treated.
9. Milking machines were never operated with more vacuum than the manufacturer recommended.
10. The pulsation speed of the milking machines was not allowed to vary much from 49 times per minute unless the manufacturer specifically recommended a different speed.
11. Milking machines were left on just long enough to remove the cow’s milk, and care was taken to avoid leaving any large amount of milk in the udder.
12. Udder injuries were avoided as much as possible.
13. Mastitis-free heifers were raised as herd replacements.
14. The cows were tested for mastitis periodically and the infected quarters treated as they occurred.

The first test of the 500 cows included palpation, the strip cup test, the Hotis test, the catalase test and a direct microscopic examination of a 24 hour incubated milk sample followed by cultural examination. About 11 months later, the milk samples from 432 of the cows in six of the same herds were given bacteriological examinations. Ten months later another bacteriological examination of the milk from quarters of 405 cows in five of the same herds was made. Throughout the entire period, the milk from each cow was tested about every three months with the catalase test. Whenever infected quarters were found, they were treated or the cow was eliminated from the milking herd. The results of the treatments are reported in Article III of this study.

**Discussion**

In spite of the fact that the herdsman handled their cows reasonably well in conformance with the mastitis control program outlined, at the end of about two years their mastitis problems were about as great as before the program was begun.

When testing was started, streptococci were the major etiological bacteria found. After one year of continuous testing and treatment it appeared that very substan-
TABLE II

SUMMARY OF THREE SETS OF TESTS OF MILK FROM COWS TO DETERMINE THE INCIDENCE OF BOVINE MASTITIS AND THE EFFECT OF PERIODIC TESTING AND TREATMENT OF THE INFECTION WITH AQUEOUS PENICILLIN INFUSIONS.

<table>
<thead>
<tr>
<th>Infective Organisms</th>
<th>First Tests</th>
<th>Second Tests</th>
<th>Third Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>500 cows in 7 herds</td>
<td>11 months after first test</td>
<td>21 months after first test</td>
</tr>
<tr>
<td></td>
<td>Quarters tested .. 1993</td>
<td>Quarters tested .. 1723</td>
<td>Quarters tested .. 1617</td>
</tr>
<tr>
<td></td>
<td>No. blind quarters .. 7</td>
<td>No. blind quarters .. 5</td>
<td>No. blind quarters .. 3</td>
</tr>
<tr>
<td></td>
<td>Percent infected .. 28.3</td>
<td>Percent infected .. 4.9</td>
<td>Percent infected .. 23.4</td>
</tr>
<tr>
<td>Strepococcus agalactiae</td>
<td>385</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>(.. .. ..)</td>
<td>68.2</td>
<td>10.7</td>
<td>2.9</td>
</tr>
<tr>
<td>Strepococcus dysgalactiae</td>
<td>14</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>(.. .. ..)</td>
<td>2.5</td>
<td>1.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Strepococcus uiberis</td>
<td>17</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(.. .. ..)</td>
<td>3.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>80</td>
<td>38</td>
<td>235</td>
</tr>
<tr>
<td>(.. .. ..)</td>
<td>14.2</td>
<td>45.2</td>
<td>62.2</td>
</tr>
<tr>
<td>Corynebacterium pyogenes</td>
<td>26</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>(.. .. ..)</td>
<td>4.6</td>
<td>15.5</td>
<td>3.7</td>
</tr>
<tr>
<td>Escherichia sp...</td>
<td>18</td>
<td>16</td>
<td>86</td>
</tr>
<tr>
<td>(.. .. ..)</td>
<td>3.2</td>
<td>19.0</td>
<td>22.7</td>
</tr>
<tr>
<td>Aerobacter sp...</td>
<td>9</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>(.. .. ..)</td>
<td>1.6</td>
<td>4.8</td>
<td>3.5</td>
</tr>
<tr>
<td>Other bacteria</td>
<td>15</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>(.. .. ..)</td>
<td>2.7</td>
<td>3.6</td>
<td>5.0</td>
</tr>
<tr>
<td>Quarters infected</td>
<td>564</td>
<td>84</td>
<td>378</td>
</tr>
</tbody>
</table>
tial progress was being made, for the overall infection percentage was down to 4.9 and the streptococci had almost been eliminated. However, at the end of two years of testing and treatment, the infection rate was up to 23.4 percent and most all of the infection was due to Staph. aureus and coliform bacteria which responded poorly to penicillin therapy.

Other dairymen whose herds are not discussed in this report followed the mastitis control program with the exception of the herd testing and treatment. They only asked for treatment of obvious cases showing abnormal milk. At the end of two years, their mastitis problems overall were not as great as those who had complete periodic herd tests and treatments.

These results indicate that until good therapeutic agents are available to use against all mastitis producing organisms, perhaps herd testing and treatment should not be advised, and perhaps not even then until more is known about mastitis. Even now with more effective antibiotics available Schalm and Woods suggest that after the elimination of S. agalactiae and Staph. pyogenes (aureus) from a herd, coliform bacteria can repeatedly reinfect a herd even though dihydrostreptomycin is useful in eliminating the infection when it appears and that perhaps the high incidence of coliform mastitis may be due to the elimination of S. agalactiae and the near elimination of Staph. pyogenes (aureus) from the bacterial flora of a herd.

It appeared that when S. agalactiae was removed from the bovine udder, the udder was then quite susceptible to Staph. aureus infection, and after Staph. aureus was removed coliform bacteria were often found in the same quarter. Perhaps some strains of S. agalactiae or Staph. aureus in a low grade “chronic infection” should actually be considered as “normal udder flora” and removal not be attempted, for as long as a herd has a substantial percentage of these “infections” the virulent Staph. aureus strains and coliform bacteria are not a herd problem.

One only has to read the many reports of bacteriological surveys of milk from bovine udders made in this country over the last twenty years to see the trend changing from S. agalactiae as being the dominant infective organisms to Staph. aureus and coliform bacteria as the infective agents of importance. This has no doubt been due to the widespread use of therapeutic agents effective against the streptococci.

The normal habitat of S. agalactiae is in the bovine udder; the organisms is found nowhere else in nature except as a rare chance inhabitant of local infections. Staph. aureus is commonly found on the skin of animals and man and consequently contaminates any surface inflammations and gains entrance to the udder through the teat canal. The coliform bacteria are normally found in great numbers in bovine feces and are a constant infectious threat when the end of the bovine teat is contaminated. However, it is of interest to note that in previously untreated or rarely treated herds as long as S. agalactiae is a dominant udder inhabitant the other bacteria are not usually a problem although the chance of infection is just as great.

Perhaps S. agalactiae has an antibiotic effect, alters the pH, has a cross-immunizing effect or in some other manner prevents other bacteria from becoming established while it is present.

Sometimes herds with a substantial rate of “infection” with S. agalactiae and Staph. aureus (as diagnosed by cultural examination) still are not considered mastitis problem herds by their owners because, if the herd is maintained carefully to prevent and avoid the predisposing factors to mastitis, very little clinical mastitis is seen. When the streptococci and staphylococci are eliminated from a herd by treatment or disposal of infected animals, coliform bacteria often establish themselves in the treated udders. An udder seems to lose immunity to bacteria as the animal grows older.

Maybe we should compare the mastitis problem of a herd with the brucellosis problem. As long as only testing and elimination of infected animals is practiced, the herd becomes more and more susceptible to the slightest chance of in-
fection. With the introduction of calfhood vaccination, brucellosis is still kept out of the herd but the herd is no longer highly susceptible to any slight exposure to infection. If a mastitis test and treatment is followed, the infected animals are treated or eliminated leaving a herd that builds up no immunity to udder infections and that becomes highly susceptible to any that might be introduced.

Perhaps a new approach to mastitis should be tried. During the “thirties,” mastitis-mixed bacterins were widely used but are now generally considered useless. More recently Collinson and Murphy report the use of a staphylococcus toxoid for mastitis treatment. Perhaps the use of biologics should again be re-examined. Maybe a herd should be tested for mastitis, and the infected cows treated until free of infection or sold. Then all animals could be given a series of toxoid injections against an organism such as Staph. aureus and after this a suspension of attenuated organisms could be injected into each udder to establish a bacterial flora which would not become pathogenic when the udder was exposed to many of the usual predisposing factors of mastitis as well as to have a bacterial flora which might prevent other more detrimental bacteria from becoming established.

Conclusions

1. *Streptococcus agalactiae* is found to be frequently the cause of mastitis in easy-milking cows. It is rarely found in the average or hard milking cows.

2. The following of a mastitis prevention program without periodic testing and treatment is useful in keeping mastitis under control.

3. The following of a mastitis control program with periodic testing and treatment with penicillin only does not control the mastitis problem; and it is also doubtful that the use of more effective antibiotics would control it.

4. Testing, treatment and elimination of incurable animals only leaves a herd highly susceptible to infection.

5. Perhaps a new approach to mastitis should be made by: (a) testing, treating and eliminating incurable cows, (b) immunizing the animals against a certain bacteria, and (c) infusing an attenuated strain of that bacteria into the sterile udders to create a new controlled udder flora.

References


A 41 per cent increase in motile sperm per ejaculate was obtained when bulls were restrained prior to service. When controlled tests were run and artificial vaginas employed, results showed that more semen is delivered when a bull is sexually excited prior to service.

Third-cutting alfalfa seems to cause scouring in calves more frequently than do other cuttings. A report on this study showed that when calves received third-cutting hay, 80 percent of them developed scours. However, of the calves which were fed first and second-cutting alfalfa, scouring occurred in less than 5 percent.

Cattle production has been increasing for four years and there are now about 93 million on our farms and ranches. It is expected that prices for cattle will be somewhat lower in 1953 than for the year just passed.

Studies on the relationship of rectal and vaginal temperatures of cows in heat indicate that if a cow in heat has a higher temperature of the vagina than of the rectum, the follicle has not burst. In the opposite case, the follicle has already ruptured. If the two temperatures are the same, it is probable that the follicle has already broken.

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