MACHINE MILKING AND MASTITIS

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SUMMARY

The hypothesis is advanced that, with a modern milking machine, operated at a normal vacuum and with a well-adjusted pulsator system, its primary role in influencing the incidence of mastitis is due to its ability to spread infection. Emphasis in the control of mastitis should be placed on adequate preparation of udders and teat-cups for milking, care in cup changing to avoid milking machine instability, increasing the vacuum regulating capabilities of the milking system, and generally improving the hygiene of the milking operation.

It is usual at present to explain the role of the milking machine in the aetiology of mastitis as due to its trauma-producing effects. Schalm in his *The Bovine Mammary Glands in Health and Disease* (1962) makes this point of view clear, and Beckley (1966) attributes the apparent relationship between vacuum instability and mastitis to the traumatic role of the former. The milking machine is clearly capable of trauma production. Witzel and McDonald (1964) show that during "overmilking" the negative pressure within the lumen of the teat is sufficiently high during a characteristic machine milking operation to damage the delicate structures of the teat and annular fold. There is ample field evidence that gross overmilking and the employment of high vacuums and poorly adjusted pulsators will cause eversion of the streak canal and other manifestations of physical damage. The writers advance the hypothesis that, with a modern milking machine, operated at a normal vacuum and with a well-adjusted pulsator system, its primary role in influencing the incidence of mastitis is due to its ability to spread infection.

McEwan and Samuel (1946) demonstrated that spraying a culture of *B. coli* against the tip of the teat during milking under normal conditions will cause the movement of infection into the streak canal and the lumen of the teat. These workers also showed that, if a cow is overmilked with liners which have been dipped in infected milk, infection of the streak canal can occur, the effect being greater when the liners are of the wide-bore moulded variety.

Prasad and Newbould (1968) demonstrated the influence of streak canal characteristics on the probability of infection moving into the udder and indicated that the probability of infection occurring during milking is of the same order as that of its occurring between milkings. Thiel (1968) repeated the experiment of McEwan and Samuel but used different velocities in the jetting of the teat with bacterial toxin. He showed that at low velocities of 5 ft (1.5 m)/sec no positive reactions were encountered, whereas with velocities of 23 and 30 ft (7 and 9 m)/sec the probability of the toxin passing through the streak canal increased. He also pointed out that the reverse flow velocity in the claw tube of a typical milking machine may be as high as 50 ft (15 m)/sec. Thus normal machine milking operation provides conditions which could permit an infection to gain access to the streak canal owing to the reverse spray effect. Dodd and Neave (1968) demonstrated that, of 993 new infections occurring in a large field experiment in one year, 300 were probably cross-infections between quarters of the same cow. Such cross-infections could well be caused by "reverse spray" infection.

The writers' hypothesis suggests that the leucocyte count of a herd of cows is substantially determined by its response to subclinical infection. If this is correct, the introduction of improved hygiene should tend to reduce it. Wilkinson (1965) describes the results of introducing back-flushing and udder washing as steps in good hygiene. Applying such hygiene to problem herds, he was able to demonstrate a reduction in the leucocyte count of the cows concerned. He also described an increase in leucocyte count following the overloading of a milking machine which was part of the survey. Adjusting the machine and improving the hygiene reversed the trend. Brookbanks (1966a) also demonstrated that the introduction of elementary hygiene produced a decrease in new infection rate. Similarly, McClure *et al.* (1966) found that, when farmers practised good hygiene during milking, 41% of cows and 15.4% of quarters gave California Mastitis Test (C.M.T.) positive reactions, while, where the hygiene was not so good, 52.4% of cows and 24.6% of quarters were positive reactors. Dodd and Neave (1968) emphasized the fact that pasteurizing the cluster and milk tube with water at 85° C for 5 seconds will produce a substantial reduction in the number of new infections. All of this points to the role of hygiene as a factor influencing the average leucocyte count of a herd.

Overmilking has been implicated as a factor in influencing mastitis. McClure *et al.* (1966) and Brookbanks (1966b) show a relationship between overmilking and the C.M.T. response.

Several workers have indicated a relationship between the instability of a milking system and mastitis (Wilson, 1963). Nyhan (1968) showed that, under conditions of low reserve air and high vacuum instability, or when the vacuum was artificially fluctuated over a wide range, there is an increase in the number of new infections and a decrease in milking rate. The influence of milking rate on leucocyte count was studied experimentally by Whittlestone and Fell (1969) using the technique of reducing air-line vacuum in order to decrease milking rate. It was shown that a significant increase in leucocyte count occurred after a period of approximately 9 weeks owing to the prolongation of milking time associated with reduced air-line vacuum.

Using the low-speed vacuum recording technique described by Whittlestone *et al.* (1963) one of us (L.R.F.) has examined the relationship between leucocyte response and different types of vacuum fluctuation and machine characteristics (Fell, 1967). Generally it may be said that purely cyclic fluctuations in vacuum are not associated with a leucocyte response, indicating that vacuum variations as such are not a causal factor. In this study it was found, despite the findings of other workers, that reserve air as such is not clearly related to a raised leucocyte count. On the other hand, vacuum regulator efficiency was significantly positively correlated with all the mastitis indices used in the study. Overmilking was positively related to mastitis, but this factor contributed less than the other significantly correlated factors. Milking time was highly significantly related to leucocyte response. Vacuum level showed a negative relationship with leucocyte response over the limited range found in this particular study of 12.2 to 15.5 in. (31 to 39 cm) of mercury. The higher vacuums were associated with lower counts. This may well reflect the influence of vacuum level on rate of milking. Irregularities such as the upper level of the milk line vacuum graph and dips caused by cup changing were also related to the leucocyte count.

Generally it would appear that, when the vacuum regulating system and the milk handling capabilities of the plant become overloaded, the resultant vacuum fluctuation tends to be associated with a raised leucocyte count. Such fluctuations are compatible with milk flowing from

the milk line back into the clusters, so being a potential vector for infection. The possibility of this occurring has been tested under conditions of moderate pipeline loading on both a 1 in. and a 2 in. (2.5, 5 cm) pipeline machine. It is evident that, under moderate loading conditions, reverse flow of milk from the pipeline into the cluster can occur. It is therefore suggested that the relationship which has been observed between machine instability and the incidence of mastitis is due to the fact that such instability is associated with the movement of milk from the pipeline into the teat-cups and an increase in the tendency for milk to move from the claw into the teat-cups. Emphasis in the control of mastitis should thus be placed on adequate preparation of udders and teat-cups for milking, obviating clumsy cup changing with its resultant machine instability, increasing the vacuum regulating capabilities of the milking system, and generally improving the hygiene of the milking operation.

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