Mastitis: the milking machine as the delivery mechanism

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Mastitis remains the most costly problem in the dairy industry after decades of research with intense focus on management practices and the introduction of modern equipment.

Published research notes that one-third of all dairy cows are estimated to have mastitis and that 50% of cows in Canada and the United States have one or more infected quarters. The report 'the Dairy Industry in Israel 2012' documents the fact that approximately 50% of milk processed is from cows with an SCC over 200,000 – the level considered to represent subclinical infections (Fig. 1).

Environment and management

Mastitis is likely the most studied problem in the dairy industry with over 4,000 publications listed in the Journal of Dairy Science alone on that topic. The investigations to date focus on the environment and management practices that are believed to be associated with the bacterial invasion of the udder resulting in the infections.

Accepted practices therefore focus on cleanliness, proper milking procedures and best management practices.

Most recently the industry has come to accept that mastitis is a fact of milking animals and is turning to technology to allow dairy farmers to gather data to better manage the cows with the infections. This approach does nothing to prevent mastitis but rather focuses on managing the problem.

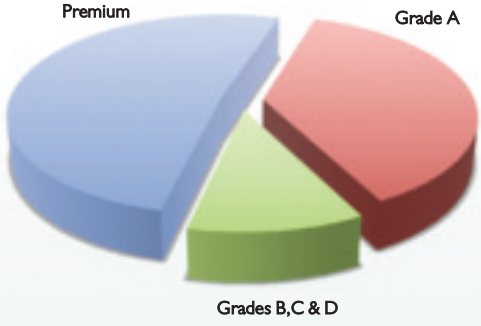
Milk extraction from a teat sinus using a syringe (Dr D. Forbes).

The published evidence shows that the actions taken to date have not addressed the root cause of the infections. Reports on cows milked with robotics show that contagious mastitis from bacteria such as Staphylococcus aureus remain a serious problem in spite of the very repeatable milking process with a quarter milking machine that self-cleans between each milking.

One study reported that in an automatic milking (robot) herd where the prevalence of Staph. aureus IMI at calving was 3% of the cows, infection spread to 67% of the cows during the one year study period. Another report noted that steaming the liners after milking was not associated with improved udder health. This data shows that there exists another mechanism for the bacteria to invade the udder.

Fig. 1. Milk supply by somatic cell count categories in 2012.

Quality grade	Count per ml	supplied milk (%)
Premium	< 220,0000	51.20
Grade A	220,001-280,000	37.50
Grades B, C & D	> 280,000	11.20



Research completed by Dr Derek Forbes in England provides evidence of the method that bacteria can invade the udder even with the best management and cleanliness practices. Dr Forbes determined that non-motile bacteria, such as Staph. aureus, is forced up the teat canal during the milking process by the pinching action of the liner. He determined that Staph. aureus can remain in the canal for weeks without causing an infection if not forced up the canal. If the contaminated teat canal is pinched by a liner the result is effectively a reverse milking action that forces the bacteria up the canal to cause an infection.

Comparison of results

Forbes approach was to extract milk directly from the teat sinus with a syringe to obtain milk that had not passed through the teat canal. The bacteria present in the milk extracted directly from the sinus were compared to those in samples collected from the teat ends by hand milking.

Cows were continued to be milked by machine and samples were regularly collected and the results compared over a period of time. The data gathered shows in some cases the samples collected by hand could have bacteria such as Staph. aureus present for many weeks before an infection was detected in the teat sinus. Other quarters quickly experienced the movement of bacteria from the teat canal to the teat sinus to cause an IMI. The variation is probably due to the shape and size of the teats, some known to have a predisposition to mastitis.

The evidence and data leads to the conclusion that the pinching of the liner on the teat end will forcibly shove the keratin lining of the teat canal carrying the bacteria up into the sinus to cause an IMI.

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This action is further supported in an NMC paper by Mein in which he reports "Cinefilm and cine-radiographic studies as

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well as ultra-sonic techniques have shown that about one third of the milk volume present in a teat sinus just before the liner starts to close, is 'pumped' back up into the udder cistern by the closing liner."

There exist videos showing this pumping action of liners driven by conventional milking machines as well as the simply objective test of placing one's fingers into a working liner and feeling that action.

The fact that the industry still suffers the serious financial impact of mastitis after decades of research and focus on cleanliness and management is proof that another mechanism of infection exists.

The research by Forbes and others strongly suggests that the conventional milking machine is the delivery mechanism for bacteria causing the infections. At the 2004 NMC annual meeting Dr Andrew Johnson stated "Since the milking machine is one of the best washing machines ever built, the teats are bathed with milk during the milking process." Alternating pulsation creates a back-and-forth pushing action within the claw causing milk to be washed up against the teats. This is combined with the liner pinching creating the action to drive the bacteria up the teat canal effectively making the milking machine the delivery mechanism for new infections. The dairy industry will never adequately address the mastitis problem until the problem of liner pinch on the teat end is solved as no amount of cleanliness or management practices will ever prevent the forcible shoving and pumping of bacteria up the teat sinus.

A proven solution

A proven solution to the problem now exists with an innovative pulsation design that eliminates the pinching action of the liner and prevents the backwashing of the teats. The solution requires a very short C phase pulsator design that can change the dynamics of the liner from a simple pinch on the end of the teat to a gentle compressive massage on the full length of the teat.

The closure of a liner is driven by the vacuum that exists within the liner as the fresh air from the pulsator enters the shell. If that fresh air enters slowly, as it does with a conventional pulsator, the liner will close at the end of the teat where the vacuum is the highest resulting in a pinching action and pumping of the bacteria and milk back up the teat sinus.

The CoPulsation Milking System is the only pulsator design in the world capable of providing a very short C phase with a rapid movement of air into the shell to allow the liner to fully close along the length of the teat providing a gentle compressive massage. This action eliminates the teat pinching, eliminates the backwash and provides the required massage action to relieve the congestion from the milking action permitting both a longer rest and milk phase.

Research by Reitsma has proven that a longer rest phase reduces the incident rate of new infections. This is achieved with a pulsator design having one solenoid dedicated to vacuum and the other to fresh air providing full separation of air and vacuum along with an unrestricted flow of fresh air through the pulsator.

Pulsation is operated at 43ppm with a 60:40 milk/rest ratio. Consequently the duration of the milk and rest phases are lengthened to provide the necessary time for a proper rest resulting in substantial reductions in mastitis yielding faster milking with improved teat and udder health.

Cornell University research published in the JDS documents a side-by-side comparative switch back study confirming the research of Forbes with data showing 16 new Staph. aureus IMI in a group of cows milked with a conventional system with only one new IMI in the same group milked with the CoPulsation Milking System. Data from commercial herds has shown similar reductions in new Staph. aureus IMI. Recent data from herds in the Netherlands using the CoPulsation Milking System have proven the effectiveness in the reduction in mastitis and antibiotic use. ■

References are available from the author on request