Milking system evaluation – Where to start?

Roger Thomson
MQ-IQ Consulting, LLC, Battle Creek, MI 49014
Corresponding author: Roger Thomson, roger.thomson@mqiqconsulting.com

Abstract

The mastitis triangle involves the cow and her environment, the milk harvest technicians and how they are trained and the equipment they are given, and the milking equipment and its impact on mastitis risk. Other points to consider are treatment protocols/residue avoidance and labor. Adding these 2 points creates a mastitis tent. Veterinarians are independent, reasonably unbiased milk quality advisors to dairy producers. Create a road map to better understand milking systems and evaluation of milking systems. The greatest risk for new cases of mastitis resides in the number of bacteria on the animal's teat end and teat skin. The 2 most important locations at which to measure vacuum are in the milking claw and the milking receiver. Keeping the milking equipment clean on the inside and outside is important to reduce the risk of new cases of mastitis.

Key words: mastitis triangle, mastitis tent, milking equipment, milking liner, milking inflation

Résumé

Le triangle de la mammite implique la vache et son environnement, les techniciens de la traite de lait avec leur formation et l'équipement qui leur est fourni et enfin l'équipement de traite et son impact sur le risque de mammite. Les protocoles de traitement/prévention des résidus et la main d'œuvre sont d'autres éléments à considérer. L'addition de ces deux éléments crée la tente de la mammite. Les vétérinaires sont des conseillers indépendants et raisonnablement impartial sur la qualité du lait auprès des producteurs de lait. Établissez une feuille de route afin de mieux comprendre les systèmes de traite et leur évaluation. Le nombre de bactéries au bout du trayon de l'animal et sur sa peau représente le plus grand risque pour de nouveaux cas de mammite. Les deux plus importants endroits où mesurer le vide sont le collecteur de lait et la chambre de réception. Garder l'équipement de traite propre autant à l'intérieur qu'à l'extérieur est important afin de réduire le risque de nouveaux cas de mammite.

Introduction

Andrew "Andy" Johnson (www.theudderdoctor.com) is credited with the creation of a tool called the "Mastitis Triangle." It serves as a guide to focus one's investigation when troubleshooting milk quality problems on a dairy farm. The 3 corners of Johnson's model are:

1. The cow and her environment
2. The milk harvest technicians, how they are trained and the equipment they are given
3. The milking equipment and its impact on mastitis risk

An expansion to the "Mastitis Triangle" has emerged from a 5-year study called the Quality Milk Alliance. Ron Erskine, Michigan State University, and Ernest Hovingh, Penn State University, identified 2 additional points that reflect emerging challenges for dairymen producing quality milk. These expended points are 1) treatment protocols and residue avoidance, and 2) labor.

I describe this new model as the "Mastitis Tent," with 4 corners and the topic of labor impacting every corner of the tent like a fabric cover. With this foundational introduction, the question for this group is: "Where does the veterinarian fit into the Mastitis Tent?" Professionally, we are trained as, and viewed by, other dairy stakeholders as the "cow people," and rightfully so. No other advisors that walk on a dairy farm have spoken an oath to care for animals as we have. In most cases, no other advisor that walks on a dairy farm has completed as much advanced educational training as we have. If our profession does not stand up and defend the statement, "It's what's best for the cow," then who will?

Three of the "Mastitis Tent" legs are clearly in our professional wheelhouse. The cow and her environment, check! The milkers, how they prep the cow and the milk letdown reflex, check! The microbiology and pharmacology of treating mastitis and residue avoidance, check! Train dairy farm employees in all aspects of animal care and use of bilingual skills to connect with them, check! Understanding the milking system and how it might impact mastitis, no confidence!

By gaining a basic understanding of the milking system, it is my opinion that we dairy veterinarians move to the top of the list as an independent, reasonably unbiased milk quality advisor to the dairy producer. The rest of my time is dedicated to creating a road map for you to start your journey toward milking system understanding and evaluation. I will use 5 common questions to start building your personal road map.

What does all of this Mean?

Question 1. Can the milking system cause mastitis?
Answer = Yes!

Research has identified the risk percentage as 6 to 20% for new cases of mastitis being "caused" by malfunctioning milking equipment. This leaves >80% of new mastitis cases

originating in the other corners of the "Mastitis Tent." And, of course, the topic of well-trained and experienced labor overarches all of these reasons for more mastitis. The most important take-home message from this presentation is this factoid. The greatest risk for new cases of mastitis resides in the number of bacteria on the animal's teat end and teat skin. This includes the non-lactating period.

Question 2. How does a milking system work?
Answer = Applies vacuum to the teat end.

Cisternal (free) milk is removable by occluding the opening between gland cistern and teat cistern and applying positive pressure externally (hand harvesting) or by applying negative pressure to the external opening of the streak canal(s). Glandular milk is removable only after it is transferred from the alveoli into the cisternal compartment of the gland by the milk letdown reflex.

Question 3. Is there any problem with applying vacuum to the teat?
Answer = Yes.

Early milking machines required cannuli insertion through the streak canal and applying vacuum to the cannula. Other early designs applied continuous vacuum to the external teat end, which created great discomfort to the animal. More than a century ago, the idea of a 2-chambered teat cup was first patented. It combined a metal outer shell with a flexible, rubber liner inside, where the teat was placed. The liner and metal case were clamped together to create an airtight space between the outside of the liner and the inside of the metal shell. This space (the pulsation chamber) was then vacummized and flooded with atmospheric air in an alternating pattern that made the rubber liner pinch shut and open. This movement pushed against the sides of the teat end, creating a massage effect that greatly reduced the painful blood congestion of continuous vacuum. Modern equipment today is fundamentally the same.

Question 4. What is the goal of modern milk harvesting by machines?
Answer = Compromise.

Everything about machine milk harvesting is a compromise. The overarching goals are:

- Speed
- Comfort
- Completeness
- Consistency

The compromise arises with the conflict between these goals.

Speed is not comfortable. Comfort is typically not fast nor complete. Completeness is neither fast nor comfortable. Consistency is very difficult because of great variation among animals on the dairy. Age, stage of lactation, speed of milk flow and teat dimensions are 4 of the greatest variations that a single parlor with 1 type of claw, shell, liner, and vacuum level must accommodate.

Question 5. What are the most important factors contributing to machine-induced mastitis?
Answer = Consistent system vacuum, consistent pulsator function, liner selection for the herd, and cow-to-cow spread of bacteria

I conclude this presentation by describing how each of these factors can contribute to increased mastitis risk, their goals and the basic method to evaluate each of them.

Consistent System Vacuum

The 2 most important locations at which to measure vacuum are in the milking claw (during peak flow) and the milking receiver (ROV during milking for >15 minutes). The ROV must be steady with <0.6 inch Hg of fluctuation. Most vacuum recorders will report 3 numbers, an average, a maximum, and a minimum. The difference between the average and the maximum and the average and the minimum must be <0.6 inch Hg.

The most important vacuum measurement is the claw vacuum at peak flow. This is the vacuum the animal feels. This is the vacuum that closes the liner and produces the massage effect on the teat end. What should this level be? It depends. The ISO range is 9.5 inches Hg to 12.5 inches Hg, but its precise level is based on what the liner needs to close and massage. You set the vacuum level at the pump to achieve the claw vacuum at peak flow needed for the liner. There is always more fluctuation of vacuum in the claw than in the receiver. This is due to the small tube (milk hose) that empties the claw and the general pathway of milk from the teat end to the large, stainless steel milk line. The acceptable fluctuation of vacuum in the claw is <2 inches Hg for a milk line below the cow's udder or <3 inches Hg for a milk line above the cow's udder.

Claw vacuum fluctuations, in themselves, generally do not cause a change in milking performance or new infection rates, unless liner slips accompany them. If the fluctuations are consistent, the cows apparently become used to them and they are called "regular" fluctuations. If they are inconsistent or wide in scope, they are called irregular fluctuations and may be something the cow can feel. The ROV vacuum is important to be consistent and can increase the risk of new mastitis cases when it increases in fluctuation, which adds to the claw fluctuation and leads to more liner slips and blood congestion in the teat.

New research is revealing the importance of minimizing blood congestion in the teat end and teat barrel. This congestion appears to produce discomfort and affect the internal diameter of the streak canal that can reduce the speed and completeness of milk-out.

Consistent Pulsation

The pulsator has 2 jobs. One is to let atmospheric air into the pulsation chamber and the other is pull air out to vacuumize the chamber. Most pulsators cycle once per second, which is 1,000 milliseconds. One cycle of a pulsator is divided into 4 phases for analysis:

A Phase = Liner opening
B Phase = Liner open
C Phase = Liner closing
D Phase = Liner closed

Typically, the liner is open (harvesting milk) 60% of the time and closed (massaging) the other 40%. Teat size, length and firmness, based on effective milk letdowns, impact the liner movement and affect the pulsation numbers. Cows like consistency. Cows can feel a difference in vacuum >0.6 inches Hg and appear to feel pulsation phase variations >10%. The impact can affect the milk letdown reflex, increase blood congestion, and produce more liner slips.

Liner Selection for the Herd

The scope of this course does not allow a deep dive into the world of liners. Interestingly, a milking system that can cost upward of $1,000,000 interfaces with the biological unit (lactating animal) through a $4 piece of rubber or silicone, called a liner or inflation. As noted earlier, the incredible variation of teat size and shape on a dairy farm makes the selection of 1 liner the ultimate compromise decision.

The choices a dairy producer must make when choosing a liner include:

Shape
- Round
- Square
- Triangle
- Oval
- Tri-circle
- Quad-circle

Material
- Rubber
- Silicone
- Hybrid

Dimensions
- Mouthpiece opening
- Mouthpiece rigidity
- Internal dimensions
- Wall thickness/tension in the shell
- Vent/Non-vented
- Location of the closure point (touch point)

General principles of liner choices include:
- Softer mouthpiece lip is more comfortable, but produces more slips.
- Higher tension or thicker wall is faster milking but more uncomfortable.
- Narrow internal dimensions milk slower, but produce lower mouthpiece chamber vacuum.
- Larger internal dimensions milk faster, but produce higher mouthpiece chamber vacuum.
- High mouthpiece chamber vacuum creates a tourniquet effect, increasing blood congestion.
- Non-vented, short milk tube vent or mouthpiece chamber vents are available.
- Silicone has longer rating for number of milkings between changes.

The goal is to choose a liner the milks as many cows in the herd as comfortably as possible. The reality is a liner that milks the highest-producing mature cows will not be comfortable for heifers. I have yet to find a dairy producer willing to change liners in the middle of a milking shift.

Cow-to-cow Spread of Bacteria

Bacteria deposited in the milk film of a liner from 1 cow can transfer to the teat skin of the next 3 or 4 cows. This is the definition of contagious spread. Liner slips create tremendous turbulence within the liner and claw, sending milk droplets flying in all directions. As stated earlier, bacteria on the teat end is the single most important factor increasing the risk of new mastitis cases. Keeping the milking equipment clean on the inside and outside is important to reduce the risk of new cases of mastitis.