BULK TANK
MONITORING PROJECT

Canton Office – 315-379-3930
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Ithaca Office – 607-255-8202

www.qmps.vet.cornell.edu

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Introduction

This manual represents a collaborative effort by the veterinarians, technicians, and administrative staff of all four Quality Milk Production Services laboratories. Our goal was to provide our clients with an easy-to-use, and complete reference for interpreting the results of the services we offer. While several of the sources (both quoted and created) are similar, we felt that each was unique enough to justify inclusion. As with any scientific topic, we expect this guide to be updated as materials, methods, and our knowledge expands in the future. We also encourage you, the consumers of this product, to contact us with your suggestions on how we may improve it.

Bulk tank monitoring Services we offer:

Somatic Cell Count

Standard Culture

Mycoplasma

Standard Culture and Mycoplasma

Quantitative analysis:
- Colony counts of all
- Major mastitis bacteria

Milk quality panel:
- Modified SPC
- Lab Pasteurized count
- Coliform Count

Complete panel:
- Quantitative analysis
- Milk quality panel
- SCC

You can refer to the case study on page 23

This is a continually evolving service that may in the future include more options. Please contact your regional QMPS lab for information. See our website (www.qmps.vet.cornell.edu) for the current prices of these tests.

The QMPS Staff of Canton,
Cobleskill, Geneseo & Ithaca

Milk bacterial counts: Regulatory and Suggested Industry Quality Standards (CFU/ml)

Test	Quality Standard			Regulatory Standard	For more information see page
	Excellent	Good	Poor		
SCC	< 200,000	200 – 400,000	> 400,000	< 750,000	-
SPC	< 5000	< 10,000	> 10,000	100,000	4,6,8,12
LPC	100	100 – 200	> 200	NA	4,6,12
Coliform	< 10	10 – 50	> 50	NA	4,12
PIC	< 10,000	10,000 – 50,000	> 50,000	NA	5,12

Suggested Bacteria Counts for Various Mastitis Pathogens in Raw Milk (CFU/ml)

Organism	Quality Standard			For more info see page
	Excellent	Good	Poor	
Staph. Aureus	< 1	100 – 500	> 500	14
Environmental *Streps*	< 500	500 – 1000	> 1000	15
Strep. agalactiae	0		> 1	13
Mycoplasma	0		> 1	19
A.pyogenes	0		> 1	18
CNS	< 500	500 – 2000	> 1000	16

Bulk Tank Milk Cultures: A Powerful Management Tool

Traditionally, Bulk Milk Cultures are used to measure compliance with regulatory standards for milk quality. Milk plants assess the bacterial quality with a **Standard Plate Count (SPC)** or **Plate Loop Count (PLC)**. The legal limit established by the Pasteurized Milk Ordinance (PMO) is 100,000 cfu/ml (colony forming units per ml of milk). These are broad-spectrum tests that indicate the number of bacteria present in milk. They do not, however, identify the type of bacteria or their origin and little diagnostic value. Additional testing (bulk milk culture) can be used for monitoring and diagnostic purposes. Bacterial contamination of milk can originate from a number of sources. Determining the type and numbers of the various bacteria present in milk can provide valuable information about mastitis, cow environment, milker performance, and cleaning and sanitation of the milking equipment. This type of diagnostic testing is most helpful when performed routinely and the results of the tests monitored as a whole to indicate potential problems well before they become serious and the producer is threatened with regulatory action.

The **Standard Plate Count** (SPC) or **Plate Loop Count** (PLC) determines the total number of bacteria in a sample that can grow and form countable colonies on *Standard Methods Agar* when incubated aerobically at 32°C (90°F) for 48 hours. Generally, SPC values should be less than 10,000/ml. The legal maximum for producer milk is 100,000/ml. At QMPS, a **Modified Standard Plate Count** is performed on *Blood Agar* which allows for identification of the bacteria. Also known as a **Quantitative Bulk Tank Culture**, it is commonly used to diagnose mastitis problems and the possible cause of high Somatic Cell Counts and may be useful in determining the cause of high bacteria counts (mastitis due to *Streptococcus agalactiae* or *Streptococcus uberis*).

A **Coliform Bacteria Count** is performed by plating a sample on *Violet Red Bile Agar* or another media which selects for coliform bacteria. Coliforms are associated with fecal and environmental contamination. Counts in raw milk should be less than 50/ml. There are no legal limits for raw milk, unless coliform cause the SPC to exceed 100,000/ml. The ***Coliform Count*** thus provides an indication of both the effectiveness of cow preparation procedures during milking, and the cleanliness of the cow's environment. Coliform bacteria in milk will degrade milk quality and may pose a public health threat. Coliform bacteria are present in soil and manure. They are present in bulk milk as a result of inadequate premilking sanitation (dirty teats and udders), contamination of the milking equipment during milking, or, rarely, from mastitis. Coliforms can also incubate in residual films left on milk contact surfaces.

The **Laboratory Pasteurization Count** (LPC) is performed by heating the milk sample to 62.8°C (145°F) for 30 minutes (simulates batch pasteurization) followed by the SPC procedure. This procedure counts the bacteria that survive pasteurization. LPC values should be less than 250/ml. The legal maximum SPC for pasteurized milk is 20,000/ml. The ***Lab Pasteurized*** or ***Thermoduric Count*** is also a valuable diagnostic tool. This test is identical to the Standard Plate Count except that it is performed on a milk sample pasteurized in the laboratory. Since pasteurization kills typical mastitis-causing organisms and Coliform bacteria, this test measures the level of heat loving (thermoduric) bacteria. Typically, these are the organisms that colonize and grow in the milk handling equipment if cleaning and sanitation procedures are inadequate.

Preliminary Incubation Count (PIC) is performed by holding a milk sample at 12.8°C (55°F) for 18 hrs. followed by the SPC procedure. This incubation temperature selects for bacterial contaminants in a sample that can grow at cool temperatures. PIC values should be less than 3-4x the SPC, or less than 50,000/ml. There is no legal limit. The ***Preliminary Incubation Count*** is considered by many milk processors to be the most reliable indicator of milk shelf life. Mastitis pathogens from the cow will not grow rapidly at these temperatures, however bacteria from the environment, or those present due to poor milking hygiene will flourish. *For proper interpretation, the PIC must be compared to the SPC of the same sample.*

These diagnostic tests can be used routinely (bimonthly) to measure milk quality, compliance of milkers with recommended sanitary procedures, the cow environment, and routine cleaning and sanitation procedures of the equipment. Larger herds (> 300 milking cows) can perform these procedures at string or group levels to better isolate and identify problems. Strategic sampling in different locations of the milk handling system, or various times during milking will quickly isolate the problem area. Testing can also help evaluate milker training and crew performance. Quality Milk Production Services, your certified milk inspector, or your herd veterinarian can help with interpretation of the data.

When combined with other milk component measures such as Somatic Cell Count, bacteria identification, MUN, % butterfat / protein, freezing point, etc. the producer is provided with a set of valuable tools that can be used proactively to optimize milk quality and productivity.

Interpretation of raw milk bacterial counts and suggested guidelines for troubleshooting high counts.

B. Jayarao, S. Pillai, D. Wolfgang, D. Griswold, L. Hutchinson. Pennsylvania State University, University Park, PA 16802.

Test and suggested counts	If counts are high for 3 out of 4 samples then the likely problem can be:	What to look for on the farm?
Standard Plate Count (SPC)	1. Improper cooling of milk	1a. Temperature of milk 2 hrs. after milking, (must be ≤ 40°F) 1b. Check the bulk tank temperature indicator/thermometer for its accuracy 1c. Ask if any recent changes have been made to cooling system
Low (Good) < 5,000 cfu/ml	2. Poor milking practices	2a. Evaluate udder preparation and milking procedures (see Table 7).
Medium (Acceptable) < 10,000 cfu/ml	3. Unclean or unsanitized milking equipment	3a. Check for detergent and or sanitizer left in the containers 3b. Check water temperature used for cleaning 3c. Inquire about water quality (chlorination, well water management, coliform count, pH, water hardness) 3d. Ask if equipment is sanitized between milkings 3e. If pails and buckets are used, ask how they are cleaned
High (Concern) > 10,000 cfu/ml	4. Mastitis	4a. Check for history of *Streptococcus agalactiae* mastitis 4b. Check for cows with subclinical mastitis (perform California mastitis test)
Lab. Pasteurization Count (LPC)	1. Unclean milking equipment and utensils.	1a. Persistent cleaning failure in some area of the milking system 1b. Same as SPC (3a – 3e)
Low (Good) < 100 cfu/ml		
Medium (Acceptable) 100 – 200 cfu/ml	2. Faulty milking machine and worn out parts.	2a. Check for leaky pumps, old pipeline gaskets, inflations and other rubber parts and milk stone deposits 2b. Check air lines and moisture traps
High (Concern) > 200 cfu/ml	3. Extremely dirty cows.	3a. Check for soiled udder and teats at time of milking. Determine if udders are inflamed, singed or clipped.

Test and suggested counts	If counts are high for 3 out of 4 samples then the likely problem can be:	What to look for on the farm?	
Preliminary Incubation Count (PI) **Low (Good)** < 10,000 cfu/ml **Medium (Acceptable)** 10,000 – 50,000 cfu/ml OR < 3x to 4x SPC **High (Concern)** 50,000 cfu/ml OR >3x to 4x SPC	1. Unclean milking equipment and utensils 2. Marginal cooling of milk 3. Poor udder preparation before milking	1a. Same as SPC (3a – 3e) 2a. Check temperature of milk in the bulk tank 2 hours after milking 3a. How are the cows cleaned and sanitized before milking? ➢ Use of an approved pre-dip? ➢ Teats dipped using a dip cup or spray? ➢ Are cows fore-stripped? ➢ Individual paper or cloth towels? ➢ Teat and teat ends thoroughly clean and dry before attaching the milking unit? ➢ Use of an approved post-dip?	

Preventing and Correcting High Raw Milk SPC and PI Bacteria Counts
- Check your procedures -

Any "No" answer is a possible cause of high bacteria counts.

	Yes	or	No
Dairy Cows			
1. Are cows clipped?	( )		( )
2. Are they reasonably clean?	( )		( )
3. Are cows fenced from swampy, muddy areas?	( )		( )
4. Is a Quantitative Bulk Milk Culture performed?	( )		( )
5. Are cows known to be free of environmental Strep. infections?	( )		( )
6. Are *A.pyogenes* infected cows clearly marked ?	( )		( )
7. Are known *S.aureus* infected cows milked separate?	( )		( )
Milking procedures			
1. Are single service paper towels used?	( )		( )
2. Are dirty cows washed and dried before pre-dipping?	( )		( )
3. Is an approved udder wash sanitizer or pre-dip solution used in proper concentration?	( )		( )
4. Is the pre-dip solution wiped off before applying the machine?	( )		( )
5. Is stripping (into strip cup) used regularly for detection of abnormal milk?	( )		( )
6. Are teats and teat-ends dry and clean before applying the machine?	( )		( )
7. Is attention being paid to liner slips and unit fall-off during milking ?	( )		( )
8. Is "wet hand milking" or stripping avoided?	( )		( )
9. Is an approved and properly labeled product being used as a post-dip?	( )		( )
General facilities and procedures			
1. Is an adequate supply of soft water available?	( )		( )
2. Is equipment rinsed immediately after use with warm (100-110^{0}F) water?	( )		( )
3. Are brushes in good condition and the appropriate brushes available?	( )		( )
4. Does examination of the milk filter (‘sock’) reveal an absence of foreign matter (sediment, straw, or sawdust)?	( )		( )
5. Are the floors of the milking area free from dust or dirt that might be drawn into milking units?	( )		( )
6. Are the chores of feeding, bedding cows, and sweeping floors avoided during milking?	( )		( )

	Yes	or	No
Milking machine and milking units			
1. Are inflations and all other rubber, plastic, and rubber-like parts clean and free from cracks or deterioration?	( )		( )
2. Are milk hoses (including stanchion hoses) cleaned after each milking with proper brushes or burrs and stored to drain dry?	( )		( )
3. Is there an absence of rust or open seams?	( )		( )
4. Are gaskets and milk valves removed, cleaned, and brushed daily?	( )		( )
5. Are claw pieces disassembled and thoroughly brushed or automatically washed after each milking?	( )		( )
6. Are check valves in good repair, in place, and seating properly?	( )		( )
7. Are pulsator air ports clean?	( )		( )
8. Does vacuum line slope to drain with drain valves at low points?	( )		( )
9. Are vacuum lines cleaned and flushed regularly (at least every 3 months) or whenever milk enters the vacuum line?	( )		( )
10. Is equipment stored to drain dry?	( )		( )
11. Are metal surfaces clean?	( )		( )
Pipeline			
1. Has a specific cleaning and sanitizing program been developed and is it followed? This should be based upon a water hardness test and give specific materials, amounts of water and cleaner, circulation times, cleaning frequency and water temperatures to use.	( )		( )
2. Are the specified temperatures maintained during the wash cycle (start >160, end >120^{0}F)?	( )		( )
3.Is the pH of the wash cycle (11-13) and the Acid rinse (less than 3) appropriate ?	( )		( )
4. Is non-CIP equipment disassembled and hand cleaned daily?	( )		( )
5. Does the entire line drain properly?	( )		( )
6. Are gaskets in good condition with flush joints and changed when necessary?	( )		( )
7. Are rubber, plastic, glass and rubber-like parts clean and free from cracks and deterioration?	( )		( )
8. Are milk port openings, swinging joints, milk pumps, and claw assembles clean?	( )		( )

	Yes	or	No
9. Does the main vacuum supply line slope away from the receiver toward the sanitary trap?	( )		( )
10. Are sanitary traps installed and properly located?	( )		( )
11. Are alternate water and air slugs maintained throughout the line during cleaning?	( )		( )

Transfer systems

1. Are milk pumps and/or releasers clean?	( )		( )
2. Are milk contact surfaces clean?	( )		( )
3. Are hoses and connections clean and thoroughly dried after use?	( )		( )
4. Is filtered air used to dry long lengths of plastic tubing?	( )		( )
5. Are sanitary traps installed and properly located?	( )		( )
6. Is sanitary trap valve closure during system cleaning (trapout) prevented?	( )		( )
7. Does more than 5 gallons of water drain from the balance tank after wash cycle?	( )		( )

Bulk tanks

1. Are surfaces clean, with no evidence of milk stone or protein deposits?	( )		( )
2. Are outlet valves, agitators, and bridge surfaces clean with no evidence of milk stone or protein deposits?	( )		( )
3. Is the temperature of the milk down to 50^{o} F within 1 hour after start of milking and to 40^{o} F or less within one additional hour?	( )		( )
4. Does the blend temperature remain below 45^{o} F at all times during 2nd and subsequent milkings?	( )		( )
5. Is it impossible for contamination to occur due to condensation from pipes and ceilings?	( )		( )
6. Is care used in rinsing the top of the bulk tanks to prevent the entrance of water when milk is present?	( )		( )

Note: Examine all milk contact surfaces when dry for evidence of deposit. A bluish or rainbow appearance on metal surfaces indicates protein buildup. An off-color white or yellowish appearance is an indication of mineral deposit. Chlorinated cleaners remove protein while acid cleaners remove milk stone. It is advisable to install a water softener when the water supply is very hard (in excess of 20 grains hardness). The use of an acidified final rinse aids in preventing water stone deposits.

Adapted from *'Preventing and correcting high raw milk SPC and PI bacteria counts'* by Stephen B. Spencer and Sidney E. Barnard, Professors of Dairy and Food Science, The Pennsylvania State University

Sources of Microbial Contamination as Detected by Various Bacteriological Procedures

Microbial contamination of raw milk can occur from a variety of microorganisms, from a variety of sources. Because of this, determining the cause of bacterial defects is not always clear and straight-forward. High bacteria counts can result from one source though they often are the result of a combination of factors (i.e. dirty equipment and marginal cooling). Other than the Standard Plate Count (SPC), a number of testing procedures may be used to evaluate the quality of raw milk. These include the Laboratory Pasteurization Count (LPC), the Preliminary Incubation Count (PIC) and the Coliform Bacteria Count. These tests generally select for bacteria that occur as contaminants that are not considered to be the natural flora of the cow. Generally, elevated counts using any of these procedures would suggest that production practices and hygiene procedures on the farm are in need of improvement. The capability of these procedures to detect bacteria from different sources and causes are summarized in the table below.

Standard Plate Count (SPC) determines the total number of bacteria in a sample that can grow and form countable colonies on *Standard Methods Agar* when incubated aerobically at 32°C (90°F) for 48 hours. Generally, SPC values should be less than 10,000/ml. The legal maximum for producer milk is 100,000/ml.

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Laboratory Pasteurization Count (LPC) is performed by heating the milk sample to 62.8°C (145°F) for 30 minutes (simulates batch pasteurization) followed by the SPC procedure. This procedure counts the bacteria that survive pasteurization. LPC values should be less than 250/ml. The legal maximum SPC for pasteurized milk is 20,000/ml.

Coliform Bacteria Count is performed by plating a sample on the media *Violet Red Bile Agar* which selects for coliform bacteria. Coliforms are associated with fecal and environmental contamination. Counts in raw milk should be less than 50/ml. There are no legal limits for raw milk, unless coliform cause the SPC to exceed 100,000/ml.

Sources of Microbial Contamination as Detected by Selected Bacteriological Procedures. * = most likely

Procedure	Natural Flora	Mastitis[1]	Dirty Cows	Dirty Equip.	Poor Cooling
SPC >10,000	Not likely	Possible	Possible	Possible	Possible
SPC >100,000	Not likely	Possible (rare)	Not likely	Possible *	Possible *
LPC >250	Not likely	Not likely	Possible	Possible *	Not likely
PIC High vs. SPC	Not likely	Not likely	Possible	Possible *	Possible *
SPC High/ No Increase in PIC	Not likely	Possible	Possible, but not likely	Possible, but not likely	Not likely but possible
Coliform Count High	Not likely	Possible (rare)	Possible	Possible	Not likely But Possible

[1] Culturing for mastitis bacteria and SCC data would be useful.

Mastitis – Causing Bacteria

While over 130 bacteria have been known to cause mastitis in dairy cows, goats and sheep, the number commonly found in high numbers in the bulk tank is much smaller. The most frequently isolated organisms are described below. They have been classified as contagious or environmental bacteria depending on the way they infect new animals: contagious bacteria spread from cow to cow, while environmental organisms are found all around the cow and pass through the streak canal from there. The presence of contagious bacteria in the bulk tank would indicate the presence of at least one infected animal in the herd. The most common source of environmental bacteria in the tank will be off the surface of the teats and udder, or from the environment itself (a unit fall off, for example). Since many environmental organisms can also cause mastitis, however, they may also come from inside the udder. Purity, or uniformity of the culture (as interpreted by a qualified laboratory technician) differentiates between these two possibilities. Under no circumstances should the number of a particular type of bacteria present in the bulk tank, be used to estimate the number of infected animals in a herd. This guide is designed to be used to interpret the results of the Modified Colony Count performed by the Quality Milk Production Laboratories. Additional information may be obtained at the Laboratory in your area.

Streptococcus agalactiae (contagious)

The most common cause of illegal bulk tank somatic cell counts, *Strep ag* can (and often does) cause high, or illegal Plate Loop Counts. These bacteria can be observed as long chains under the microscope which leads to a diagnosis of "mastitis" as the cause for a high bacteria count by milk laboratory personnel. It typically does not cause clinical mastitis, but the infected cow's scc usually does rise markedly. These bacteria multiply only in the udder but can survive for short periods on skin and milking machine parts. These infections are spread from an infected animal to herdmates on hands, inflations, common towels, and other items used during milking. Calves that can cross-suckle can also spread this disease. Purchased animals can bring *Strep ag* into the herd. Use of contaminated milking equipment at fairs or auctions will also spread these infections.

Because cows exhibit no clinical signs when infected, *Strep ag* can spread insidiously throughout the herd and is usually only identified when high bulk tank somatic cell or bacteria counts are noticed.

Management

- Culture milk from cows in the herd.
- Treat all cows that culture positive for *Strep ag* at the same time in all four quarters with an approved intramammary treatment. Penicillin drugs are usually effective.
- Milk all infected cows last until subsequent cultures are negative.
- Dip all teats after milking with an approved product.
- Eliminate use of common wash towels.
- Wear latex or nitrile gloves and frequently disinfect when contaminated with milk or manure.
- Separate calves that are fed discard milk so that cross suckling does not occur.
- Milk purchased animals separately and culture milk samples before mixing these animals with the remainder of the herd.

- Treat all cows at dry off with an approved intramammary product.
- Cull the rare cows that do not respond to therapy.
- Once *Strep ag* has been eliminated from the herd, monthly bulk tank cultures should be done for at least six months to ensure that the herd is free of this disease.

Staphylococcus aureus (contagious)

Another contagious mastitis pathogen, *Staph aureus* is actually more widespread across New York State than *Strep ag*. *Staph*-infected animals do not tend to consistently shed bacteria, but it has been known to impact bacteria counts in isolated instances.

Staphylococcus aureus is the organism responsible for causing the most common type of contagious mastitis in dairy cattle. Udders are the usual source for new infections, however these bacteria are also found on the skin of most cows and in the environment. Mastitis caused by *Staph aureus* damages the milk producing tissues and can decrease milk production by 45% per quarter. The bacteria damage the udder tissue producing areas of walled off infection that are unaffected by antibiotic therapy. In addition to milk production losses, elevated somatic cell counts are seen and may be accompanied by recurrent bouts of clinical mastitis.

The bacteria are spread primarily during milking from an infected cow to its herdmates by milking equipment, milker's hands, common towels and other items used during milking. It may colonize lesions on the ends of the teats and thereby gain entrance to the gland through the teat canal. Teat injuries or teat chapping may also introduce *Staph aureus* mastitis into a herd. Calves that can cross-suckle can also spread this disease.

Staph aureus commonly produces chronic infections that will persist from one lactation to another despite dry cow therapy. New infections in young animals may respond to antibiotic therapy but often these animals are infected for life. Cows that do not respond to treatment should be culled.

Management

- Milk known *Staph aureus* cows last, with a separate unit, for as long as they are in the herd. If possible, segregate them to their own group or area of the barn.
- Dip all teats with an approved product immediately after milking. During cold weather use teat dips containing sufficient levels of emollients to avoid chapping.
- Wear latex or nitrile gloves and frequently disinfect when contaminated with milk or manure.
- Maintain milking equipment to avoid liner slips, improper vacuum levels, and overmilking.
- Change rubber inflations every 800 cow milkings.
- Use effective lactating and dry cow treatments based on culturing and antibiotic susceptibility results.
- Separate calves that are fed discard milk so that cross suckling does not occur.
- Cull chronically infected cows.
- Avoid housing pregnant heifers with dry cows when a significant number of cows in the herd are know to be infected with *Staph aureus*.
- Milk purchased animals separately and culture milk samples before mixing these animals with the remainder of the herd.

Corynebacterium bovis (contagious)

C. bovis is a Gram positive bacterium that inhabits infected udders and the teat canal. They are commonly found in low numbers in the bulk tank, but rarely affect the total bacteria count. Spread of *C. bovis* occurs primarily cow to cow at milking time. These bacteria can cause mild udder infections with a mild increase in somatic cell count and slight reduction in milk production. Rarely do they cause clinical mastitis. An increased incidence of these infections in herd warrants reassessment of teat dip product and application methods. Most infections are self-limiting and do not necessitate antibiotic therapy.

Management

- Teats should be predipped with an approved product and dried with individual use towels.
- Dip all teats with an approved product immediately after milking. Cups are preferred over sprayers for consistent teat dip application.
- Dry cow therapy will eliminate *C. bovis* infections.

Streptococcus species (environmental)

Streptococcus species (non-agalactiae *Strep*) include *Streptococcus uberis* and *Streptococcus dysgalactiae* as well as many other species of *Strep*. The environment is the primary source for these bacteria; hence they are called 'environmental *Streps*'. These bacteria are found in bedding, manure, and mud and infections acquired in the dry period; either during the first two weeks after dry off or during the two weeks prior to calving. Because of their wide distribution throughout dairy farms, the presence of low numbers of these organisms in bulk tank samples is common. They also form chains, and can be confused with Streptococcus agalactiae under the microscope.

These bacteria may cause either a clinical mastitis with abnormal milk, swelling of the gland, and fever or a subclinical mastitis with no apparent signs. Individual cow somatic cell counts are usually elevated and infected cows can shed millions of bacteria into the bulk tank. Most of the infections caused by *Strep* species are eliminated by the cow's immune system or by antibiotic therapy within 60 days; however some infections (`18%) will become chronic.

Culturing cows with clinical mastitis or those that have chronically elevated cell counts (greater than 4.5 linear score on two consecutive DHIA tests) and conducting antibiotic susceptibility trials will provide information that will allow you and your veterinarian to design the most effective treatment protocols.

Management

- Minimize exposure to dirty environmental conditions. Adequate amounts of clean, dry bedding should be provided in all stalls. Inorganic bedding (sand) is associated with fewer pathogens than organic bedding (straw, shavings, sawdust, and paper pulp). Wet or soiled bedding should be removed daily. Alleys, walkways, and holding areas should be scraped free of mud and manure on a regular basis. Ponds, streams, and shady areas should be fenced.
- Only attach milking units to clean, dry teats. Teats should be predipped with an approved product and dried with individual use towels.

- Strip 4-5 squirts of milk from each teat prior to milking to detect clinical mastitis earlier.
- Maintain milking equipment to avoid liner slips, improper vacuum levels, and overmilking.
- Wear latex or nitrile gloves and frequently disinfect when contaminated with milk or manure.
- Establish treatment protocols based on culture and antibiotic susceptibility results.
- Consider dipping teats for two weeks after dry off and for two weeks prior to freshening.
- Ensure that adequate amounts of Vitamin E and selenium are fed.

Coagulase-negative *Staphylococcus* (species) (environmental)

Coagulase-negative *Staph* (CNS) can be normal inhabitants of bovine skin or live in the environment in bedding, manure, and mud. They frequently gain access to the udder between milkings and are normally not contagious. CNS are one of the most common organisms cultured from dairy cows (10 to 15% of quarters is common) but are usually associated with subclinical mastitis and only moderate increases in somatic cell counts. Because of their wide distribution throughout dairy farms, the presence of a low number of these bacteria in the bulk tank is common.

If a herd is experiencing a high incidence of CNS infections, post milking teat dip products and application should be re-evaluated. In general, CNS can be resistant to antibiotic therapy and most infections will resolve on their own. Persistent infections will likely clear during the dry period.

Management

- Minimize exposure to dirty environmental conditions. Adequate amounts of clean, dry bedding should be provided in all stalls. Inorganic bedding (sand) is associated with fewer pathogens than organic bedding (straw, shavings, sawdust, and paper pulp). Wet or soiled bedding should be removed daily. Alleys, walkways, and holding areas should be scraped free of mud and manure on a regular basis. Ponds, streams, and shady areas should be fenced.
- Only attach milking units to clean, dry teats. Teats should be predipped with an approved product and dried with individual towels.
- Strip 4-5 squirts of milk from each teat prior to milking to detect clinical mastitis earlier.
- Maintain milking equipment to avoid liner slips, improper vacuum levels, and overmilking.
- Ensure that all teats are adequately covered with an approved dip immediately after milking.
- Ensure that adequate amounts of Vitamin E and selenium are fed.

Escherichia coli (environmental)

E. coli is a Gram negative bacterium (coliform) that is commonly found in bedding, manure, water, and soil that can cause life-threatening illness. Most of these infections occur during the first two weeks prior to calving through the first two months of lactation. Infection occurs when the teat end contacts contaminated material between milkings. During the incubation period, *E.coli* multiplies rapidly and can be shed in extremely high numbers in the milk affecting the Plate Loop Count as well as the Coliform Count. Chronically infected animals may do the same.

Following entrance of these bacteria into the gland, most infections are of short duration with approximately 50% lasting less than 100 days, although a handful may become chronic lasting more than 100 days. Ten percent of the cows may have a sudden onset of fever, markedly

decreased milk production, loss of appetite and dehydration. Often these cows will go down and be unable to rise. Milk from the affected quarter may have large clots or be watery or bloody. Supportive therapy with anti-inflammatories and fluids is usually required for these cases. Antibiotic therapy is often of little benefit. The cow's immune system will effectively kill the bacteria; most clinical signs are due to toxins produced by the bacteria. Immunization can reduce the incidence and severity of clinical cases.

Management

- The most effective management measure is to keep cows clean and dry, particularly in the dry cow and prefresh areas.
- Avoid overcrowding of pens to prevent access to muddy corrals and pastures and areas of standing water.
- Predip with an approved product and dry teats well with individual use towels before attaching milking units.
- Maintain milking equipment to avoid liner slips, improper vacuum levels, and overmilking.
- Good nutrition and control of fresh cow metabolic diseases reduce the cow's susceptibility.
- Use effective dry cow treatments based on culturing and antibiotic susceptibility results.
- Consider the use of immunization for coliform mastitis during the dry period and early lactation.
- For cases of severe, acute mastitis discuss treatment protocols with your veterinarian.

Klebsiella species (environmental)

Klebsiella species are Gram negative bacteria (coliform) that are commonly found in organic bedding, manure, and soil. Many of these infections are associated with the use of green sawdust or recycled manure bedding. Rates of new infections are higher in summer than in other seasons. Most of these infections occur during the two weeks prior to calving through the first two months of lactation. Infections occur when the teat end contacts contaminated material between milkings. Like *E.coli*, infected animals can shed high numbers of bacteria raising the Plate Loop and Coliform Counts.

Klebsiella infections are typically very difficult to treat, and the infected animals, or individual quarters, usually have to be culled. Some cows may have a sudden onset of fever, markedly decreased milk production, loss of appetite and dehydration. Often these cows will go down and be unable to rise. Milk from the affected quarter may have large clots or be watery or bloody. Supportive therapy with anti-inflammatories and fluids is usually required for these cases.
Antibiotic therapy is often of little benefit. The cow's immune system will effectively kill the bacteria; most clinical signs are due to toxins produced by the bacteria. Immunization can reduce the incidence and severity of clinical cases.

Management

- The most effective management measure is to keep cows clean and dry, particularly in the dry cow and prefresh areas.
- Avoid the use of green sawdust, wet wood, or recycled manure bedding.
- Avoid overcrowding of pens to prevent access to muddy corrals and pastures and areas of standing water.

- Predip with an approved product and dry teats well with individual use towels before attaching milking units.
- Maintain milking equipment to avoid liner slips, improper vacuum levels, and overmilking.
- Good nutrition and control of fresh cow metabolic diseases reduce the cow's susceptibility.
- Use effective dry cow treatments based on culturing and antibiotic susceptibility results.
- Consider the use of immunization for coliform mastitis during the dry period and early lactation.
- For cases of severe, acute mastitis discuss treatment protocols with your veterinarian.

Arcanobacterium pyogenes (environmental)

A.pyogenes is a Gram positive bacterium that is frequently the cause of 'summer mastitis'. Sources for these bacteria include wounds, abscesses, and damaged teat ends. These infections are frequently spread by flies or by teat end contact with a contaminated surface. Once an infection is established, the prognosis is poor or loss of the quarter is expected. The severe clinical mastitis caused by *A.pyogenes* is characterized by a thick, yellow, foul smelling discharge. These infections are unresponsive to antibiotic therapy. *A.pyogenes* can arrive in high numbers in the bulk tank from quarters in the initial stages of mastitis that are still subclinical and being milked, or from mistakenly applying teat cups to nonfunctional quarters that have been lost to the disease. A few drops of that pus can contain **enormous** numbers of bacteria and somatic cells. Units should never be attached to blind quarters.

Management

- Maintain clean, dry, well-bedded cow areas. Stalls should be comfortable and overcrowding should be avoided to minimize teat injuries.
- Establish an effective fly control program.
- Separate calves so that cross-suckling does not occur.
- Predip with an approved product and dry teats well with individual use towels before attaching milking units.
- Maintain milking equipment to avoid liner slips, improper vacuum levels, and overmilking.
- Milk cows infected with *A.pyogenes* last, or with a separate unit.
- Cull infected cows or quarters.

Yeast (environmental)

Yeast are microorganisms that are found in a variety of areas such as soil, plants, decaying organic matter, and bedding. Other on-farm sources can be contaminated multidose bottles of medication, contaminated syringes and teat cannulae. *Yeast* may arrive in the bulk tank from the environment, or from an infected cow's udder but they rarely are present in high enough numbers to cause elevated bacteria counts. The primary means of spread is by intramammary infusions where aseptic technique has not been followed, but cow to cow at milking time when improper procedures or faulty milking equipment is used may also occur. *Yeast* mastitis is characterized by swelling of the gland, marked reduction in milk production, thick yellow or flaky mammary secretions, and fever. Clinical signs often intensify after treatment with antibiotics, so antibiotic therapy should not be used.

Management

- Care during teat disinfection (swabbing teat ends with alcohol) and single use treatment tubes should be used.
- Strip out affected quarters and milk infected cows last or with a separate unit.
- Clip or flame hair on udders.
- Avoid liner slips and unit fall-offs.

Prototheca (environmental)

Although not technically a bacteria, this algae will grow on bacteria count media and be counted accordingly. *Prototheca* tends to cause severe clinical mastitis in dairy cows which becomes chronic. Somatic cell counts as well as bacteria counts are normally elevated. Contaminated, standing water is the usual original source of this organism, but cow to cow spread is also suspected. It does not respond to antibiotic therapy and infected animals should be culled.

Management

- Keep cows away from standing, stagnant water and avoid letting water collect in freestall areas and barnyards.
- Care during disinfection (swabbing teat ends with alcohol) and single use treatment tubes should be used.
- Avoid treatment with multidose bottles of medication
- Strip out affected quarters and milk infected cows last, or with a separate unit.
- Cull infected cows from the herd.

Mycoplasma (environmental)

Mycoplasma spp. Are highly contagious organisms that may be found in infected udders, joints, urogenital tracts, and the respiratory / auditory (ear) system. The organisms may be brought onto a farm through the purchase of infected cows or heifers, and is transmitted from cow to cow at milking time on hands, equipment and common towels. Aerosol transmission from animals with respiratory signs is also known to occur. Multiuse treatment bottles, syringes and cannulae may also become contaminated.

Early infections may be subclinical. A drastic drop in milk production characterizes clinical mastitis and may vary from thick-appearing milk, to a watery, sandy consistency. Infections often spread from an initial quarter to involve all four. These infections do not respond to antibiotic treatment, so once an animal is infected, she will carry the organism for life and should be culled. *Mycoplasma* do not grow on Standard Plate or blood agar, so they do not affect bacteria counts.

Management

- Culture all herd replacements, including heifers. When buying animals, multiple bulk tank cultures from the herd of origin are recommended.
- Culture all animals with clinical mastitis or long term high SCC.
- Cull cows infected with *Mycoplasma* spp. or strictly segregate and milk separately.

- House young stock and lactating animals separately.
- Avoid feeding discard (mastitic) milk to calves.
- Teats should be predipped with an approved product and dried with individual use towels.
- Wear Nitrile gloves and frequently disinfect when dirty or contaminated.
- Maintain milking equipment to avoid liner slips, improper vacuum levels, and overmilking.
- Dip all teats with an approved product immediately after milking.
- Care during disinfection (swabbing teat ends with alcohol) and single use treatment tubes should be used.
- Avoid treatment with multidose bottles of medication

Sample Collection & Transport

Although the tests and counts run by QMPS are not official, samples for analysis should be collected in the same manner as those for the official, monthly tests. This may be accomplished by having your milk hauler take an additional sample at your regular pickup and immediately refrigerate the sample until it is turned over to the testing laboratory. If the sample is to be collected by the producer, the correct procedures to follow include:

- Be sure the milk temperature is below 40˚ F.
- Agitate milk in the bulk tank for at least 10 minutes.
- Collect the sample with a sterile straw, sanitized dipper, or sterile vial.
- **PLEASE SUBMIT 2 LARGE VIALS OF MILK FOR SAMPLING**
- Record the name, date and any other pertinent information on the vial (e.g. group, shift, etc.).
- Immediately refrigerate the sample. If the sample will not be delivered to the laboratory within 24 hrs., the sample should be frozen. (**Note:** For official test purposes, samples may not be frozen and must be processed within 36 hrs. of collection. While it is best to work with freshly – collected samples, this is not always possible nor required for our test purposes).
- Whether samples are transported directly to the lab by the producer, or shipped via a courier (U.S. Mail, UPS, Fed Ex), insulated coolers and ice packs should be utilized. (**QMPS laboratories have reusable mailers available for this purpose.)**
- Adequate ice should be added to maintain the temperature of the sample below 40˚ F.
- Samples should not be shipped over the weekend or holidays.

The US Department of Transportation (USDOT) has recently enacted new regulations concerning the shipment of diagnostic samples by means of common carriers (US Postal Service, UPS, Fed Ex, Airborne Express). The new regulations are part of an effort to protect workers and the general public from accidental exposure to human and animal disease pathogens.

Diagnostic samples must be packaged in <u>triple packaging</u> consisting of:

- **Primary container** (milk sample vial) must be leak-proof.
- Contact between primary containers must not occur during shipping.
- All primary containers must be placed in a leak proof **secondary container** (Heavy-duty zip-lock bag).
- The secondary container must contain sufficient absorbent material (paper towel) to absorb the entire contents of the package.
- An inventory of contents (QMPS sample submission forms) must be placed in the shipping box outside of the secondary container.
- The outside of the **shipping container** must have the words **"Diagnostic Samples:"** and the international symbol for **"Biohazard"** prominently displayed.
- 

New regulations may delay the shipment of improperly packaged samples to the lab. Please ensure that they are adequately refrigerated, and properly labeled and addressed. Whenever possible, ship samples early in the week to avoid arrival on the weekend.

QMPS will do everything possible to make compliance with these new shipping regulations as simple as possible for our clients. QMPS is providing appropriate packaging and shipping materials at a nominal cost to expedite transportation of diagnostic samples to the lab. Kits are available for 8, 30 and 50 to 100 samples. Improved packaging should eliminate any delays in delivery improved sample quality and more reliable test results.

Materials can be ordered from QMPS by phone, or from the QMPS website. Please call if you have any questions or concerns.

Case Report: Monitoring Bulk Tank Cultures

The project. A 500+ cow dairy agreed to participate in a project that included:

- Monitoring the incidence of a dozen commonly-occurring diseases or conditions and their effect on production;
- Sampling for culture every clinical case of mastitis;
- Saving for culture and differential count a sample from every bulk tank that left the farm.

Samples were collected weekly, and culture results available approximately two weeks post sampling (unless otherwise requested). After an initial period of adjustment to establish the most effective routine, the entire milking herd was sampled for culture in early Jan. '00. The milking system and milking procedures were also evaluated at the same time, and all was found to be functioning properly.

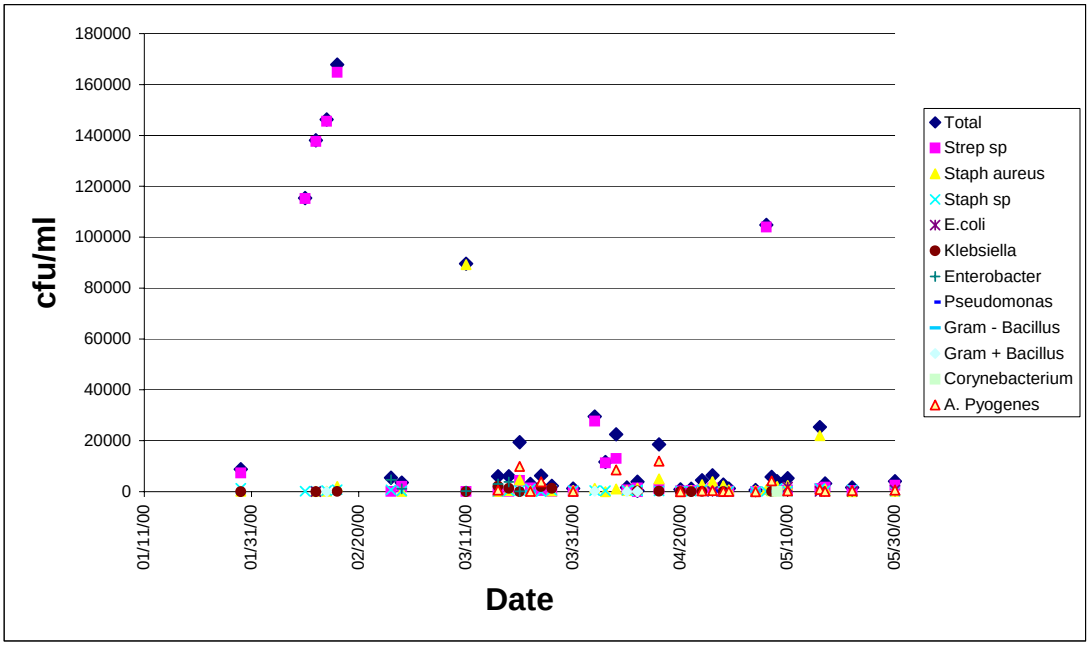
Culture results from the whole herd survey showed only about 10% of the animals with major mastitis pathogens, which was consistent with the milk quality scores received – BTSCC less than 300,000, and SPC less than 10,000. The highest incidence of clinical mastitis typically occurred during July and August with coliform bacteria responsible for the bulk of the cases so it was also expected that less than 2% of the herd would be showing clinical mastitis in January.

Less than 3 weeks later, the producer called to say he had just been informed of a high bacteria count on a sample taken in early February, and could we tell what was the cause? That sample, along with the those immediately preceding it were already being worked with and the clinical samples from the period immediately before were also being cultured. Chart 1 shows the results of the differential count as performed by our QMPS Laboratory in Ithaca. The first elevated count actually occurred in late January, and was due to a huge increase in pure non-ag *Streptococci*. Two cow samples submitted just after this contained high numbers of the same organism, but they were then withheld when being milked after receiving oxytocin, and were not in the subsequent samples that were still elevated. Somatic cell counts indicated that two animals were positive for *Strep species* at the January survey had elevated linear scores two months in a row and these animals were immediately sampled. Results showed that they too were shedding enormous numbers of *Streptococci*, and holding them out returned the tank bacteria count to normal (< 10,000).

Other episodes. The chart also shows there were other instances when the bacteria count jumped up, and each was due to an increase in a major mastitis pathogen: *Staphylococcus aureus*, in March and mid May, and *Streptococcus species* (again) in early May. The first *Staph* and the *Strep* case were attributable to animals with clinical mastitis, but the high *Staph* count in May was most likely due to a chronic cow that just happened to shed at that time, and could not be identified by culture thereafter.

Recommendations. Although the project continues, this producer (and others) will be encouraged to follow these recommendations to monitor bulk tank Standard Plate Counts:

1. Routinely maintain the milking/cleaning/cooling system.
2. Sample and submit for culture or freeze all clinical cases of mastitis.
3. Freeze and retain a sample from each bulk tank until results are cleared.
4. Reevaluate mastitis treatment protocols to possibly use antibiotic preparations on more of the "routine" cases once culture results are known (this was the topic of a presentation at NEDPA about 5 years ago).
5. In the event of a high bacteria count, have that frozen sample cultured and a predominant organism identified, if possible. Match that organism with previous culture result to identify specific animals for further culture.
6. Be suspicious of chronic high cell count cows as another possible source of bacteria.
7. If conductivity information is available, this may help identify a potential problem.



Producer: **NYSCHAP PREMISE #**

Address:

Phone: **Fax:** **e-mail**

COUNT	**Goal**	**Current Date**
SOMATIC CELLS	<200,000	
Modified SPC	<10,000	
LPC	<100	
COLIFORM	<100	
PIC	<3X SPC or <50,000	

Staph aureus

Env. Streptococci

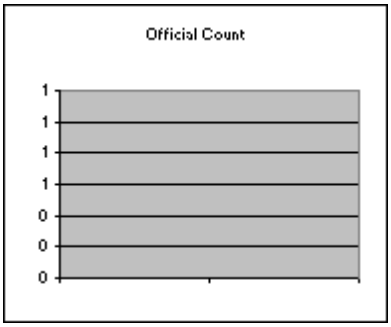
Strep ag

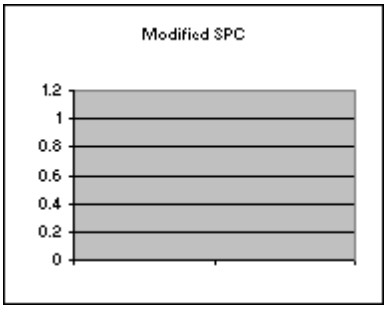
E. coli

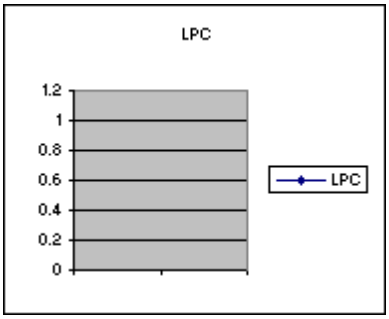
Other:

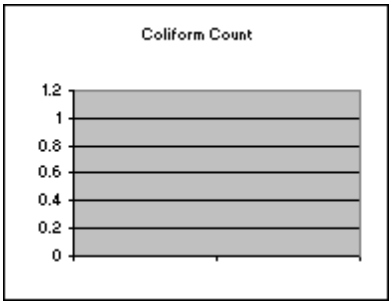
SUMMARY:

CC:









Quality Milk Production Services	well Veterinary Technology Center. 34 Cornell Drive, Canton, NY 13617 (315) 379 - 3930 (Fax) 379 - 3931	Bulk Tank Culture / Milking String Culture	Date Acc. No.

Herd Owner Address:	Practitioner Address:
Phone/Fax:	Phone/Fax:
County:	**PLEASE SUBMIT 2 LARGE VIALS FOR TESTING**

History of the problem:

Sample Id	List tests by Code	Sample Id	List tests by Code
1.		6.	
2.		7.	
3.		8.	
4.		9.	
5.		10.	

Laboratory Comments:

TESTCODE	DESCRIPTION OF TESTING PROCEDURES
BTC- A, M, or B	**Bulk Tank Culture** lists pathogens identified from the sample without a count: **BTC-A (Aerobic only) BTC-M *(Mycoplasma only)* BTC-B (Both Aerobic & *Mycoplasma)***
MBC	**Modified Bacteria Count.** Provides a count of each bacteria identified in the sample.
PANEL or SPC/CC/LPC	**Milk Quality Panel:** Includes **Standard Plate Count (SPC)** provides a total count of bacteria present in the sample without identification of the organisms. **Coliform Count (CC)** counts fecal coliform bacteria present in the sample. **Laboratory Pasteurized Count (LPC)** provides a count of bacteria that survive pasteurization (thermoduric) in the laboratory.
BTSCC	**Bulk Tank Somatic Cell Count.** Provides a count of the somatic cells mostly associated with udder inflammation.
COMPLETE	**Complete Panel** Includes MBC, SPC, CC, LPC, BTSCC, and *Mycoplasma* *See our website www. qmps.vet.cornell.edu for complete description and interpretation of tests or request our brochure.*

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