Treat the Treatable and Manage the Rest: Managing the Bulk Tank Somatic Cell Count and Reducing Treatment Costs

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Abstract

Farm income for many dairies can be improved by increasing the value of milk by taking advantage of somatic cell count (SCC) based milk quality premiums and reducing treatment costs. Recent research has shown that the likelihood of an animal to have a repeat case of clinical mastitis after a first clinical case is about 30%. Pathogen-based treatment protocols should provide a science-based process for selecting the most appropriate treatment and duration of treatment resulting in high bacteriological cure rates and fewer repeated clinical cases. Many infections caused by gram-positive organisms, particularly streptococcal species, respond well to appropriate treatment; cure rates can approach 80% or higher. Most gram-negative pathogens respond poorly to intramammary treatment. Mastitis caused by other pathogens, such as yeast, are exacerbated by intramammary treatment and others, like *Prototheca* species and mycoplasma, have no known treatment. Generally the normal distribution of mastitis pathogens is about one-third gram-positive organisms, one-third gram-negative pathogens, and one-third no growth culture result, suggesting that pathogen-based treatment protocols have the potential for substantial savings.

Duration of treatment for specific mastitis pathogens should have a major influence on cure rates, particularly for a range of streptococcal species and select *Staphylococcus aureus* infections.

There are also opportunities to manage chronic subclinical infections which are often the major contributors to the bulk tank SCC. Milk from high cell count cows can be managed through treatment, segregation of high SCC milk at the quarter level, quarter dry-off, and culling.

Résumé

Les revenus de la ferme laitière peuvent s'accroître en améliorant la valeur du lait par l'entremise des primes de qualité du lait basées sur les comptages de cellules somatiques et en réduisant les coûts de traitement. Des travaux récents ont démontré que les chances de récidive de la mammite clinique après un premier cas sont de près de 30%. Des protocoles de traitement axés sur les pathogènes devraient permettre un processus plus objectif et scientifique pour choisir le traitement approprié et la durée de ce dernier afin d'obtenir un taux de guérison bactériologique plus élevé et d'avoir moins de récidives cliniques. Plusieurs infections engendrées par des organismes à Gram positif, particulièrement les espèces de streptocoques, répondent bien au bon traitement avec des taux de guérison approchant les 80% ou plus. La plupart des pathogènes à Gram négatif répondent moins bien au traitement intramammaire. Les mammites causées par d'autres organismes, comme les levures, sont exacerbées par le traitement intramammaire alors que celles causées par d'autres organismes, comme les *Prototheca* et les mycoplasmes, ne sont pas traitables présentement. Généralement, la distribution normale des pathogènes de mammite est la suivante : un tiers causé par des pathogènes à Gram positif, un tiers par des pathogènes à Gram négatif et un tiers sans résultat de croissance. Cette distribution suggère que des traitements axés sur les pathogènes devraient engendrer des économies substantielles. La durée du traitement pour des pathogènes spécifiques de la mammite devrait avoir une influence majeure sur le taux de guérison, particulièrement pour les infections causées par maintes espèces de streptocoques et dans certains cas impliquant *Staphylococcus aureus*. Il existe aussi des chances de gérer les infections chroniques subcliniques qui contribuent souvent fortement au comptage de cellules somatiques dans le lait de réservoir. Le lait de vache avec des comptages de cellules somatiques élevés peut se gérer par un traitement, par la ségrégation du lait avec des comptages élevés au niveau du quartier, par le tarissement du quartier et par la réforme.

Introduction

Mastitis is considered to be the most common and costly infectious disease of dairy cattle in the US and throughout much of the world. Milk producers spend millions of dollars on mastitis treatments annually, and the costs are borne directly by the producers. Treatment

of infected cows is valuable for both clinical and subclinical mastitis cases. The treatment decision process varies greatly from farm to farm. Treatment decisions may be based on clinical signs shown by the cow, availability and cost of medication, or by past clinical experience perceived by the producer. On many farms, treatment of clinical mastitis with intramammary (IMM) medication can be substantially reduced without compromising treatment success.

The treatment decision strategy currently used by many veterinarians and recommended by Quality Milk Production Services (QMPS) is to base all IMM treatment decisions on the culture result and severity of clinical signs. The same strategy can be applied to the management and treatment of chronic subclinical mastitis to reduce chronic infections in the herd and manage the bulk tank somatic cell count (BTSCC). This approach does not compromise treatment success, yet can significantly reduce treatment costs, control and reduce the flow of animals through the treatment pens, substantially reduce discarded milk, and reduce the risk for drug residues. Treatment based on culture result is more complex, but more rewarding for both farmer and veterinarian.

Historically, treatment of mastitis was limited to clinical cases as a means of returning the affected quarter and animal to production of saleable milk and normal production levels. As our understanding of mastitis infection dynamics increased, antimicrobial therapy was applied to dry cows to treat existing infections and prevent new infections during the dry period. Although many commercially available IMM products are labelled for use in subclinically infected animals, they are under-utilized as a tool to manage chronic subclinical infections. Their use to manage chronic subclinical mastitis and bulk tank milk SCC is seeing a resurgence of interest.

Clinical Mastitis

Recent research at Cornell University[1,11] has estimated the costs and milk loss associated with repeated cases of clinical mastitis. In second and greater lactation, milk loss associated with a single clinical mastitis episode was estimated to be 563 lb (256 kg). Losses associated with second and third repeated clinical cases were 524 lb (238 kg) and 475 lb (216 kg), respectively (Figure 1). In addition to those losses, an animal with a clinical case of mastitis in a previous lactation will experience an average loss of 2.6 lb (1.2 kg)/day in the current lactation as compared to herdmates that did not have a case of clinical mastitis in the previous lactation. The likelihood of an animal to have a repeat case of clinical mastitis after a first clinical case is about 30%.[1] Improving bacteriological

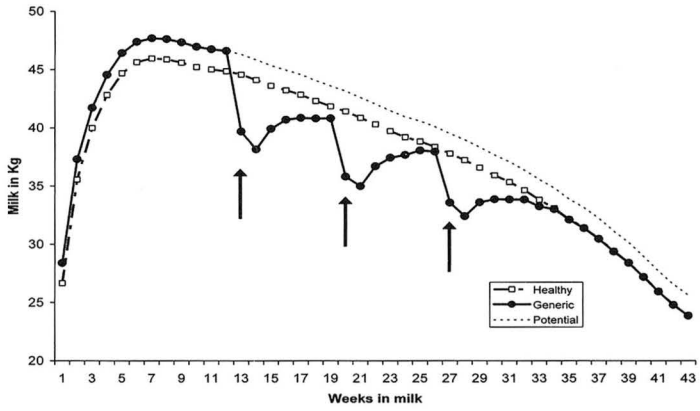

Figure 1. Effect of repeated cases of clinical mastitis on the lactation curve of multiparous animals. From Bar D, *et al*: Effect of repeated episodes of generic clinical mastitis on milk yield in dairy cows. *J Dairy Sci* 90:4643-4653, 2007.

cure rates should result in fewer chronic infections and repeated clinical cases.

Pathogen based treatment protocols provide a science-based process for selecting the most appropriate treatment and duration of treatment, resulting in optimal bacteriological cure rates and fewer repeated clinical cases. Pathogen based treatment of clinical infections will reduce the duration of many infections, a direct treatment effect. Indirect treatment effects of pathogen based management of mastitis are to reduce the numbers of new infections by reducing the numbers of existing infections (shedders of specific pathogens in the herd), thereby reducing infection pressure.[9]

Veterinarians are well aware of the range of microorganisms that can infect the bovine mammary gland, as well as the capabilities and limits of currently available treatments. Many infections caused by streptococcal species and other selected gram-positive organisms respond well to appropriate treatment; cure rates can approach 80% or higher.[3,4,5,7,8] Treatment success of infections caused by other organisms including some coliform organisms (*Eschericia coli* and *Klebsiella* species) may respond to a few select antimicrobials. A recent clinical trial conducted by QMPS has shown that mild infections involving *E. coli* and *Klebsiella pneumoniae* have improved cure rates when treated with IMM ceftiofur for five consecutive days (unpublished data). Most other gram-negative species respond poorly to IMM treatment. Mastitis caused by other pathogens such as yeast is exacerbated by IMM treatment and some, like *Prototheca* species and mycoplasma, have no known treatment. Considering that any given herd is plagued with a variety of mastitis pathogens, there are substantial opportunities to better manage treatment based on pathogen identification. The end result is more

focus on sustainable cures, reduced treatment costs, a substantial decrease in the risk for drug residues in milk or meat, and less pressure for the development of antimicrobial resistance.

Treatment of streptococcal infections is usually profitable and cure rates can be high.[3,5] Even among *Streptococcus* species cure rates will vary by species, making species identification valuable for treatment decisions. Higher economic returns are associated with higher cure rates, therefore treatment of *S. dysgalactiae* is likely more profitable that treatment of *S. uberis*. Because *S. dysgalactiae* is more contagious than *S. uberis*, the rewards are also likely to be greater. Treatment of select cases of *Staph. aureus* infections will be more profitable on farms where there is a moderate to high risk of transmission. However, other control procedures, including segregation of known infected animals for milking and effective milking procedures (use of single-use towels, frequent hand disinfection and effective teat dipping) must be applied consistently.

Cow Factors Affecting Treatment Success

A review of cow, pathogen, and treatment regimen of *Staph. aureus* mastitis provides some valuable guidelines for selection of animals infected with *Staph. aureus* for treatment.[2,4,7,8] Cow factors that were shown to influence the success of treatment include:

- Parity – first and second-lactation animals have significantly higher cure rates than third-lactation and greater.
- Front vs. rear quarter – infected front quarters cured more frequently than rear quarters.
- SCC – animals with lower SCC (<1 million) cured at a higher level than animals with higher SCC.
- Number of infected quarters – the greater the number of infected quarters, the lower the cow cure rate.
- CFU of culture plates – the greater the colony forming units on the diagnostic plate, the lower the cure rate
- Chronicity (number of positive samples) – the longer the duration of infection, the lower the cure rate.
- Days-in-milk (DIM) – in two studies, increasing days-in-milk increased the cure rate. In one study, higher DIM decreased the likelihood of a cure.

Similar criteria also influence streptococcal infections.

Pathogen Factors Affecting Treatment Success

Host adaptation is recognized across all mastitis pathogens. Genetic differences between host-adapted and opportunistic strains are being identified and are becoming more evident as newer molecular based diagnostic technologies are applied to outbreak investigations of environmental mastitis. Host-adapted organisms result in longer infection duration and repeated clinical cases. At QMPS, we are seeing increasing evidence of this with a number of traditional environmental pathogens including *Klebsiella* species, *E. coli*, and *S. uberis*.

Staph. aureus is a host-adapted mastitis pathogen with one or more predominant clones present in the herd. An additional search of the literature also shows that *Staph. aureus* organisms, which are penicillin resistant, have lower cure rates when treated with many other antimicrobials, including non-β lactam products. Antimicrobial sensitivity testing of *Staph. aureus* organisms for penicillin resistance may be in order before introducing a new treatment regimen in a herd.

Treatment Factors Affecting Treatment Success

Treatment factors include:

- Antimicrobial drug of choice
- Drug combinations
- Duration of therapy
- Route of application
- Cost
- Residue or milk/meat withhold period

Because there is neither time nor space for a discussion of pharmacokinetics of antimicrobials in the mammary gland, I will limit my focus on duration of therapy, which does influence treatment success for a variety of common mastitis pathogens, and the recommendations provided by QMPS veterinarians to practitioners and dairy farmers. There is extensive evidence that a period of extended IMM therapy will substantially improve bacteriological cure rates of *Streptococcus* species infection in general, and more specifically for *S. uberis* mastitis. For this reason we often recommend five to seven days of treatment for new clinical infections caused by *S. uberis* and a total of seven days of therapy for chronic infections. Two to three treatments for new clinical *S. dysgalactiae* provide very good results; however, we typically recommend five consecutive treatments for chronic subclinical infections. Our standard recommendation for IMM treatment of both clinical and subclinical *Staph. aureus* infections is seven to eight days, based on the criteria described above.

Therapy Based on Severity of Clinical Infection

The severity of a clinical mastitis should influence the treatment protocol applied to a given case. For this reason, we have established diagnostic protocols to determine case severity and assist herd veterinarians and farmers in creating treatment protocols based on

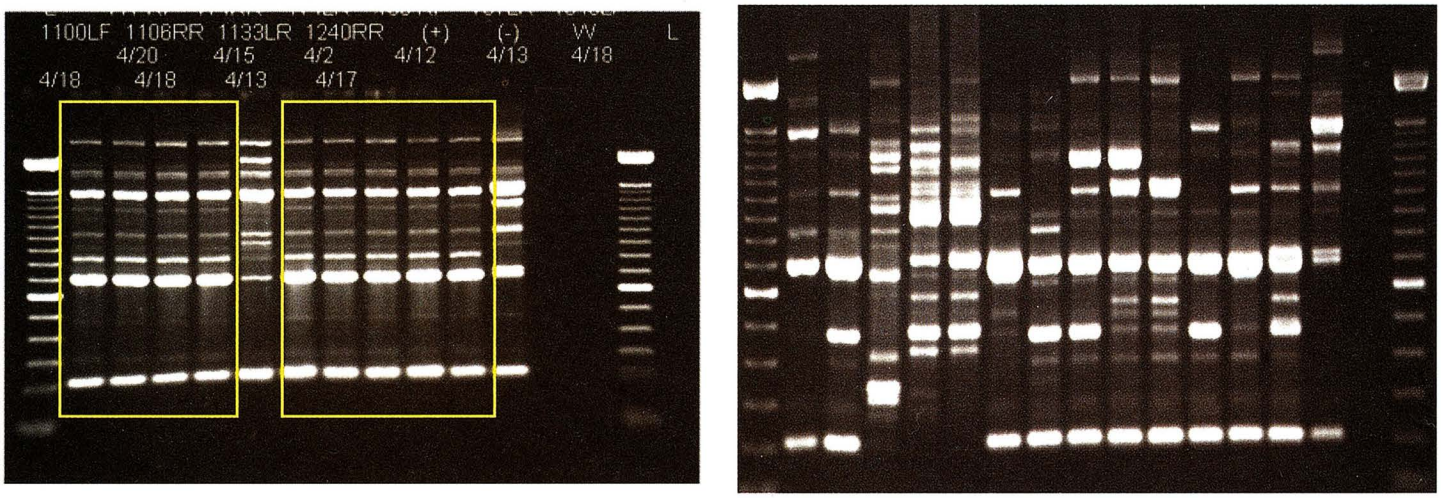

Figure 2. RAPD strain typing of *Klebsiella pneumoniae* from two herd outbreaks. The pattern on the left indicates that all strains (but one) are the same, suggesting point source or contagious transmission. All identical strains were found in a single management group. The lone different strain was in a different management group. The pattern seen on the right is more typical of a *Klebsiella* mastitis outbreak; all strains are different, indicating non-point source or environmental source.

severity of signs and the milk culture result. The diagnostic protocol adopted most frequently is one proposed by Roberson,[6] which is based on signs demonstrated by the appearance of the milk, the mammary gland, and the cow. Simply stated, no treatment is applied to mild or moderately severe cases until the milk culture results are available. Preliminary laboratory results are typically available to the producer 24 hours after the sample is received by our lab. Specific treatment protocols are applied to quarters with streptococcal species and *Staph. aureus* infections. Animals with "no growth" results or other pathogens are managed by other means such as quarter milking.

Animals with severe infections are treated immediately with supportive therapy which should include systemic antibiotics to control septicemia, intravenous and oral fluids and electrolytes to address hydration issues, and anti-inflammatory drugs to control pain and inflammation. IMM therapy is applied to severe cases only if the identified pathogen meets treatment criteria.

Chronic Subclinical Mastitis

The vast majority of somatic cells found in bulk tank milk (>70%) most often originate from cows with subclinical mastitis. Attempting to create and control BTSCC levels below 200,000 by managing clinical mastitis alone will not be productive. To effectively manage BTSCC you need to identify and manage herd infection rates, particularly chronic subclinical infections. In many if not the majority of herds, a very small portion of the lactating animals (5-10%) are responsible for a significant portion of the BTSCC.

The recommended method to manage subclinically infected cows is to review test day somatic cell counts to identify and culture individual animals. If cell count data is unavailable, it is possible to use California Mastitis Test (CMT) scores to identify individual high SCC animals and quarters. The recommended protocol for managing chronic subclinical infections can be seen in Figure 3. QMPS recommends that each animal with at least two high SCC values be evaluated with a CMT paddle to target the suspect quarter for culture. When mastitis pathogens are identified, herd managers should consult with their veterinarian and develop a customized treatment protocol to give the best opportunity for a cure. High cell count quarters that are not selected for treatment or those quarters that do not respond to treatment may be managed with a quarter-milker, dried off or culled.

It is also important that managers and herd veterinarians look at other individual cow characteristics when making management decisions. These should include age, days-in-milk, reproductive status (days carried calf), milk production, other health issues, and previous mastitis pathogen identification. Some cows may be obvious cull candidates; others may be classified as "do-not-breed" for future cull planning, and therefore are not targeted for a milk culture. These animals will remain in the herd until they are unproductive, at which point they are culled.

Identifying treatable subclinical infections often requires a higher level of culture diagnostics since treat-

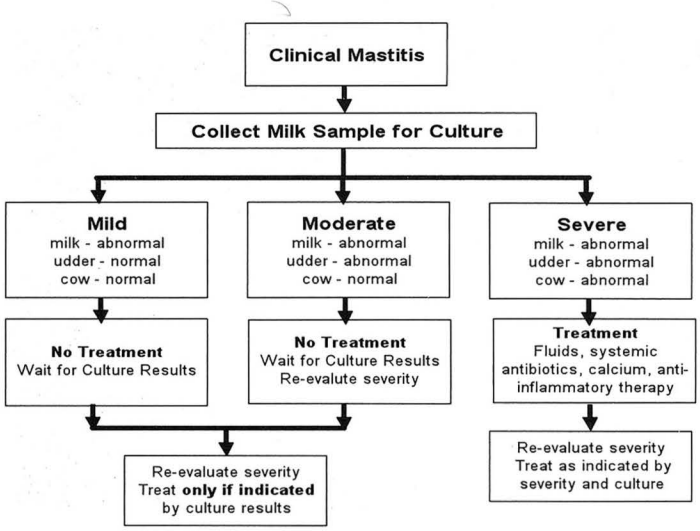

Figure 3. Diagnostic scheme for classification of clinical mastitis cases.

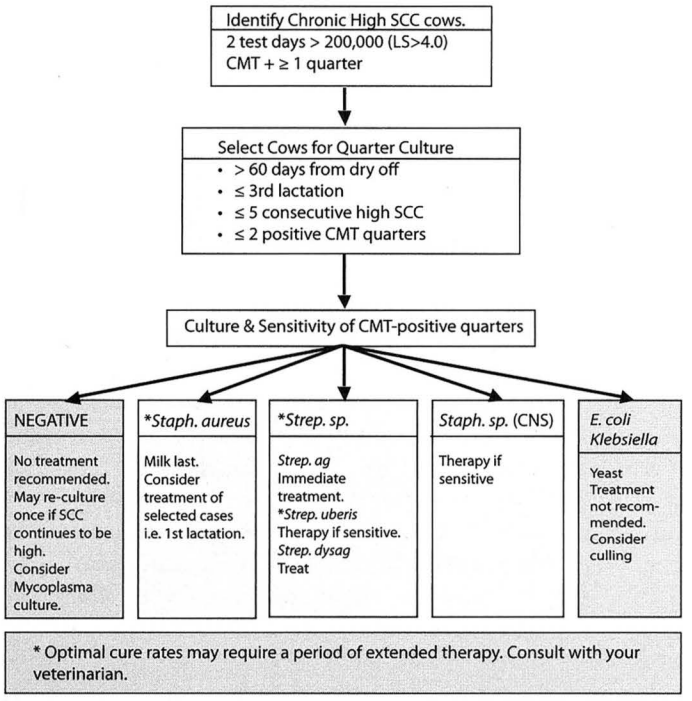

Figure 4. Subclinical mastitis treatment protocol.

ment selection and duration can vary greatly, especially for a variety of common streptococcal species (ie: *S. uberis, S. dysgalactiae), Enterococcus sp,* or *Lactococcus sp*. The only way to gain specific *Streptococcus* species information is to use techniques and tools typically not utilized by the on-farm lab, but commonly practiced in professional laboratories. This approach to therapy and milk quality management opens the opportunity for veterinary practices to provide milk culturing services for clients. On-farm culturing is also a solution for many farms to provide timely treatment of mastitis.

Treatment of coagulase-negative staphylococci (CNS) may be appropriate in some herds. CNS infections may be major contributors to the BMSCC in herds with consistently low somatic cell counts. Treatment of individual chronic subclinical CNS cases may be warranted.

Quarter Milking Systems

High cell count quarters that are not selected for treatment, or those quarters that do not respond to treatment, may be managed with a quarter-milker. Quarter-milkers are being used by some of our herds to manage bulk tank cell counts and increase the value of milk through quality premiums. Several herds in our area have developed and are currently using unique quarter-milking systems to manage high cell count milk from cows with single affected quarters. One 2,000-cow farm has installed a dedicated second milking system (high line) with eight quarter-milking teat cups to harvest high cell count milk. These are permanent systems that have little negative impact on milk harvest efficiency. They consist of a large reservoir for collecting high cell count milk and a single teat cup to milk the affected quarter. Quarters that are selected for quarter milking include infections that are not selected for treatment based on culture result. Treated animals past their designated milk withhold date can also be milked with the quarter-milker for a period of time until the SCC level in the affected quarter decreases to a specified level. Cows milked with the quarter milker are evaluated weekly with a CMT to estimate SCC levels. Many quarter-milked cows can be removed from the list in two to four weeks. Managers need to make decisions concerning those animals with more persistent infections, which may include drying off the affected quarter, planned culling or continued milking with the quarter-milker.

Benefits of quarter milking include increased milk value, decreased drug use and treatment cost, less risk for drug residues, and reduced size of the hospital pen. Photos of quarter milking systems are illustrated in Figure 5.

Conclusions

Mastitis pathogen distribution among herds is often unique, with individual herds having dominant pathogens and different dominant strains of specific pathogens contributing to both clinical and subclinical mastitis. Treatment and prevention protocols should be herd-specific consistent with the farm's resources, milk quality and udder health goals.

Mastitis pathogens present in the herd should be identified and the information used to assign treatment

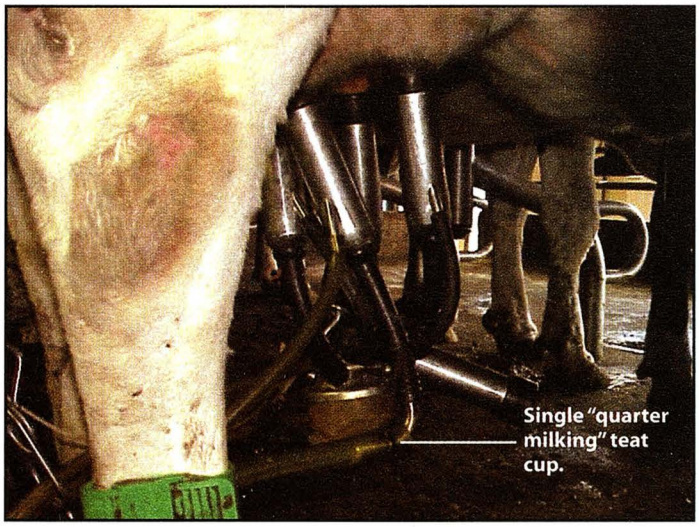

Figure 5a. Single teat cup used to milk high-SCC quarters.

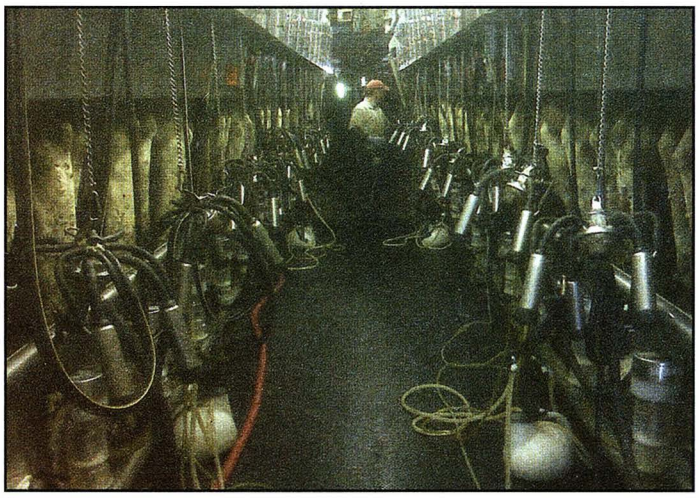

Figure 5c. Double 10 parallel parlor with four independent single teat cup units for quarter milking.

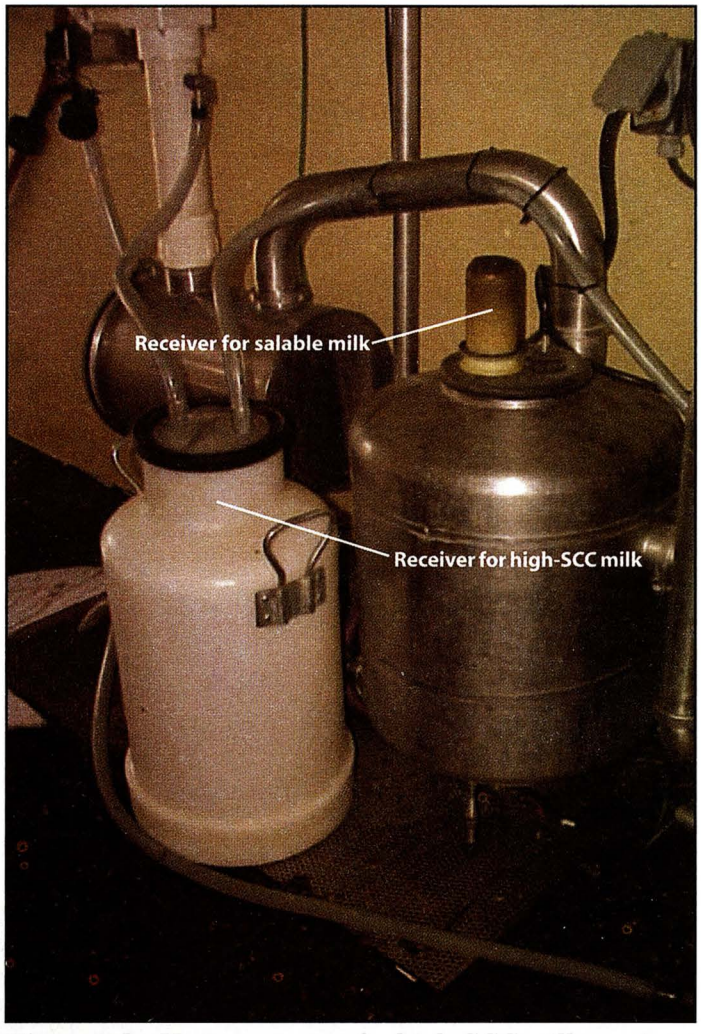

Figure 5b. Vacuum source for high-SCC milk receiver.

protocols. Individuals on the farm who are responsible for implementing the protocols and monitoring their compliance should be trained on a scheduled basis.

Herd veterinarians should use all the data available to make information based management decisions. Necessary information should include Dairy Herd Improvement data (individual animal SCC and milk production) and cow/quarter milk culture results. Other valuable data that enhance the decision process include cow value, reproduction status, parity, and SCC history for the current and previous lactation.

Monitoring treatment performance is important for long term success for both individual animals as well as the herd effect on BTSCC. The herd veterinarian is in the best position to perform this task. Establishing alternative management procedures for milk from animals not suited for IMM therapy is an equally important component of a milk quality and udder health management program.

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