

# MASTITIS CULTURE PROGRAMS FOR DAIRY HERDS

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## Introduction

Our understanding of the epidemiology of contagious and environmental mastitis has facilitated the development and implementation of control programs to deal with these two distinct diseases. While the control of contagious mastitis has concentrated on cow and milker hygiene during milking, the control of environmental mastitis has focused on dry cow programs, stalls and bedding. Although most dairy producers and veterinarians understand the importance of controlling mastitis, the routine herd health **monitoring** systems employed to identify and define mastitis problems are not necessarily capable of prompt detection of changes in the patterns of disease that could be indicative of a need to redirect control strategies.

## Monitoring Herd Udder Health

There are at least two components to a mastitis **monitoring** program (Fetrow, 1994). The first is to establish a **surveillance** system, designed to detect a mastitis “problem” as early in its development as possible. The second is to implement a **status monitoring** protocol to assess the efficacy of implemented changes. The latter includes documenting a decrease in disease occurrence that is a result of the implemented change and/or identifying increases in disease that result from failed implementation or poor compliance with the recommended control strategies. While most dairy herds have some components of this system in place, few have implemented a complete program.

Recognizing that environmental mastitis often manifests as an outbreak of clinical disease, while contagious mastitis is generally subclinical and often leads to elevated somatic cell counts (SCC), surveillance systems strive to detect both diseases. In most instances these include tracking bulk tank somatic cell counts (BTSCC) and/or DHI herd average somatic cell counts (HASCC) for contagious mastitis problems, and periodically reviewing the records of clinical mastitis cases to detect environmental outbreaks.

The **surveillance system for contagious mastitis** is based on routine evaluation of somatic cell counts. Individual cow test results from SCC, California Mastitis Test (CMT) and electrical conductivity may also be incorporated into the surveillance process. An increase in the herd or management group SCC can signal a herd-level problem, but often not until it is broadly disseminated and well established. Unfortunately, large high producing herds may be well into an outbreak before the SCC profile changes enough to trigger an action (Guterbock, 1984). Once a change in SCC is detected, there is a need to collect and culture milk samples (often composite samples from high SCC cows or all milking cows) in order to identify the pathogens involved. While high SCC problems are generally thought to be associated with contagious pathogens, this is

not always the case. In fact, it is imperative to first determine whether the predominant organisms involved are environmental or contagious, and then to conduct a thorough investigation using all available information to identify all of the component causes of the problem so that a solution can be found.

An adjunct to cow and bulk tank SCC's for contagious mastitis surveillance is the periodic culture of composite milk samples from all or some milking cows in the herd. Strategic herd-level culturing programs may serve two important purposes. First, they can identify changes in the prevalence of contagious and/or environmental mastitis pathogens before a problem is reflected in increased clinical cases or an elevated SCC. Second, they can identify specific cows infected with major contagious pathogens that may pose an infection risk to herd-mates and herd additions. Unfortunately, the costs associated with whole herd culture may be prohibitive in some herds.

The **surveillance system for environmental mastitis** is based on periodic review of clinical mastitis case records. The majority of environmental mastitis problems are identified through the investigation of "outbreaks" of clinical cases. Based on the parity and stage of lactation distributions of these cases, combined with bacteriological culture results from quarter milk samples collected prior to antibiotic treatment, the source of the problem can often be identified and a solution developed. Computer-based and paper herd management records lend themselves well to recording and storing the necessary cow-level data. Unfortunately, in many herds these record systems are implemented reactively, rather than proactively.

Once a herd mastitis problem has been investigated and a control strategy implemented, there is a need to monitor the status of the herd's udder health in response to the actions taken. The **status monitor** should be capable of providing evidence that the implemented strategy has been effective in resolving the problem, or detecting breakdowns in the control strategy. For example, in a contagious herd which has modified milking order and improved milking hygiene, periodic culture of milking cows to detect further cow to cow transmission (new cases) may be warranted. In an environmental herd which has cleaned up the calving pens, strategic culture of all fresh cows within 72 hours of calving might be most appropriate.

While BTSCC and/or HASCC are useful surveillance tools, they are less efficient for monitoring the status of a herd's response to a problem. Even when effective changes in management result in a decrease in clinical or sub-clinical cases, pre-existing mastitis cases may keep herd SCC averages elevated for prolonged periods of time. The resulting lag in SCC response could be misinterpreted as failure to resolve the original problem.

### Culture Programs for Dairy Herds

Many forms of herd culture programs have been suggested and implemented (Leslie, 1994), but few have been formally evaluated. These programs include 1) periodic culture of all milking cows in the herd; 2) strategic culturing of herd additions and all cows and heifers at dry-off and/or freshening; 3) culturing all clinical cases of mastitis identified in the herd; and 4) periodic culture of bulk tank milk samples. Each of these programs has significant strengths and weaknesses, and each may fill an important niche in the development and implementation of effective surveillance and status monitoring systems for mastitis in dairy herds. The best combination of these programs

to use in a specific herd will depend on the goals and objectives of the udder health program on that farm.

It is important to remember that bacteriologic culture is a test, similar to the SCC and CMT. While culture has long been considered the gold standard against which other mastitis diagnostic tests are compared, there is no doubt that culture alone is not perfect. Attempts have been made to evaluate and report the sensitivity and specificity of quarter, cow composite and bulk tank milk culture as a means of identifying major contagious pathogens (Buelow, 1999; Dinsmore, 1991; Erskine, 1988; Godkin, 1989; Jensen, 1990; Kelton, 1999). In general, the sensitivity and specificity of milk culture systems vary with many factors. These include the organism being sought, the sample type (quarter, cow composite or bulk tank), the condition of the sample (fresh or frozen), the duration of infection, the shedding pattern of the organism, the medium used for culture, the volume of milk plated and the frequency of sampling.

All of the aforementioned issues must be considered when interpreting milk bacteriological culture results. The value of trained and experienced laboratory personnel cannot be overstated. Interpreting bacterial growth on various culture media is not a completely objective process. Bacteriological culture interpretation is a combination of art and science. It is a process in which small differences in colony characteristics or numbers can have major consequences when they are acted upon in the field. Given the complexity of standardizing and consistently interpreting bacteriologic culture results, it is highly recommended that the field personnel acting on the culture results have faith in the quality of the information their laboratory provides. A strong positive relationship built on trust, communication and understanding is vital to the establishment of a surveillance or monitoring system based at least in part on milk culture.

### 1 - Periodic Culture of All Milking Cows

Collecting an aseptic composite milk sample from every milking cow in the herd on one day, usually at milking, is the most appropriate means by which to estimate the prevalence of major pathogens among cows in the herd, and to identify individual cows infected with contagious pathogens. Sampling can be scheduled with the diagnostic laboratory to ensure that the fresh samples are plated promptly. Alternatively, milk samples can be frozen and stored for short periods of time, with the added benefit of increasing the probability of identifying contagious pathogens present in the samples (Villanueva, 1991; Schukken, 1989).

While seldom incorporated into a routine surveillance system, the whole herd culture is often used to investigate high SCC problems and to develop control strategies. The composite culture results, in combination with individual cow SCC, can be used to identify and segregate (either by creating a separate management group or adjusting the milking order) cows known or likely to be infected with a major contagious pathogen (usually *Staph. aureus*). There may be value in repeating this process periodically after implementing the control strategy, to verify that the spread of infection among cows is being minimized and that the herd's udder health status is improving.

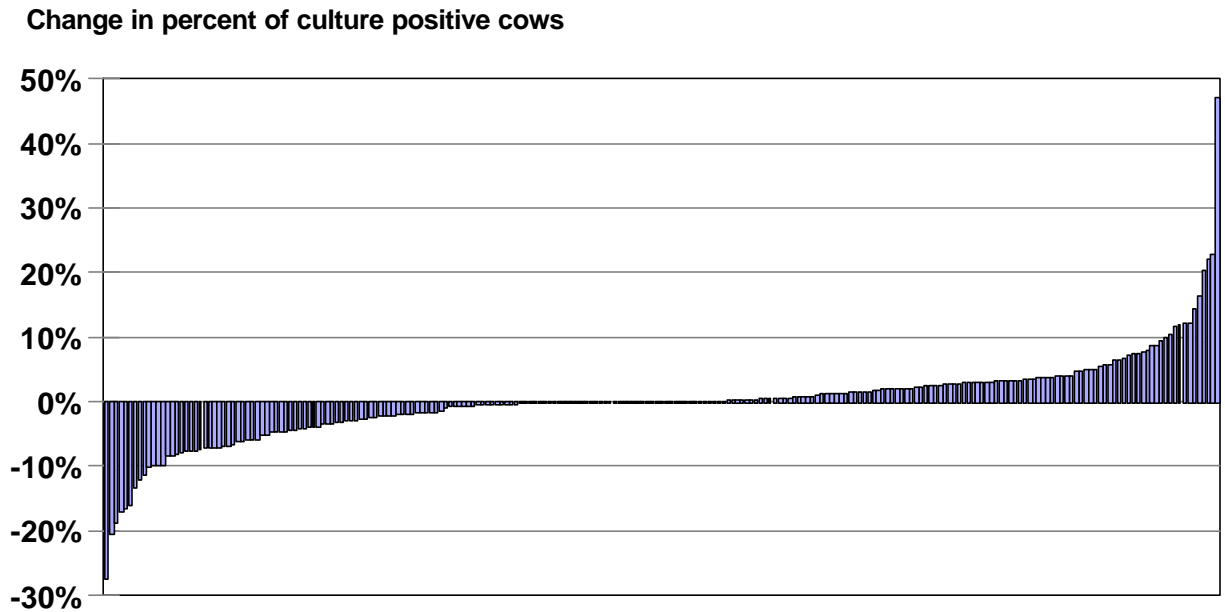
Unfortunately, the cost of sampling and culturing all cows in a large herd may be prohibitive. Selection of specific high risk animals or groups (low to moderate SCC early to mid-lactation cows) may be a reasonable compromise. Repeatedly culturing chronically infected cows is not

warranted. In dealing with contagious mastitis herds, the relatively poor sensitivity of a single culture for identifying *Staph. aureus* positive cows needs to be considered (Beulow, 1999). Double sampling strategies can be implemented to decrease the false negative rate of diagnosis, given that there is a reasonable expectation of benefit over cost.

In spite of the cost and the risk of false negative cow culture results, whole herd culture may be the best way to identify herds with an increased incidence of new infections resulting from a breach in within-herd biosecurity practices. Questions remain as to how frequently whole herd cultures need to be done. There is a lack of published literature that addresses the value and accuracy of sequential whole herd culture compared to an appropriate gold standard. Key among the unresolved issues is how large a change in pathogen-specific prevalence, from one herd culture to the next, is biologically and statistically relevant.

Results from the Ontario Sentinel Herd Project suggest that even a four month interval between herd cultures may not be frequent enough for early detection of a cow-to-cow spread of *Staph. aureus*. During an eighteen month period, 60 dairy herds had whole herd cultures done 5 times, at 4 month intervals. Eleven herds experienced increases of at least 10% in the prevalence of cows culture positive for *Staph. aureus* from one herd culture to the next, on one or more occasions (Figure 1). Equally important was the observation that most herds did experience small changes in prevalence from one test to the next. Given this consistent within herd variation over time, care must be taken not to over-interpret the significance of a single whole herd culture. Frequency of whole herd culture will remain an individual herd decision and may well vary depending on the biosecurity, alternative monitoring methods and management practices employed on the farm.

**Figure 1. Change in prevalence (%) of cows culture positive for *Staph. aureus* from one whole herd culture to the next (an interval of approximately 4 months).**



## 2 - Strategic Culture of Herd Additions, High SCC Cows and Cows at Dry-off and/or Freshening

An alternative to whole herd culture is to strategically collect composite milk samples from high risk individuals at critical points in the lactation. Most dairy herd biosecurity protocols recommend that new additions to the herd be cultured at least once, prior to or shortly after, arrival in the herd to prevent or minimize the impact of introducing contagious pathogens to the milking herd (Wilson, 1997). This practice, while not often employed (NAHMS,1996), represents an important component of the mastitis surveillance system. Given the importance of identifying *Staph. aureus* infected cows, especially in low or zero prevalence herds, and the relatively low sensitivity of cow SCC (Hoblet, 1988) or a single milk culture for detecting *Staph. aureus*, serial sampling over several days should be considered.

Many dairy herds subscribe to DHI services, which include monthly cow SCC determinations. Since contagious mastitis generally manifests subclinically, and will eventually result in an elevation of the cow's SCC, the strategic culture of new high SCC cows may offer an opportunity to identify infected cows. However, it is important to remember that there is a lag between the time of new infection of a quarter and the detection of an increase in the cow composite SCC. Furthermore, when evaluating SCC against culture for detecting cows with prevalent mastitis infections, a threshold of 200,000 cell/ml. had a sensitivity of 73% and a specificity of 86%, implying that about one quarter of infected cows would not be selected for bacteriologic culture (Dohoo, 1991)

Since most cows are treated at dry-off with an intra-mammary antibiotic and are examined at or shortly following calving, these are often convenient times to collect composite samples for

culture. Depending on the size of the herd, samples can be stored frozen and submitted for culture in convenient batch lots. The bacteriological culture results from dry-off samples of previously uninfected cows can be useful in monitoring the efficacy of contagious mastitis control programs. Culture results from fresh cow samples are useful for monitoring the status of the dry and transition cow environment, especially during high mastitis risk periods such as the warm summer months and times of increased calving density. It is not clear how soon after calving these samples should be taken to best reflect the true status of the fresh cow or heifer. Although SCC determinations for milk from fresh cows is highly variable, the sensitivity and specificity of bacteriological culture of colostrum has not been formally addressed.

### 3 - Culture of Clinical Cases

As previously described the sampling and culture of quarter samples from clinical cases should be an integral component of environmental mastitis surveillance systems. Samples can be frozen and submitted for culture in convenient batched sets, although freezing of samples may decrease the likelihood of identifying coliform organisms (Schukken, 1989). Culture negative clinical samples are common, and are generally assumed to be from coliform infections that were sampled at a time when milk bacterial numbers were low (Eberhart, 1984; Smith, 1985). While the majority of clinical cases of mastitis in most herds are environmental, contagious pathogens may also be identified through this process.

Results of clinical sample cultures are used to determine the incidence of pathogen-specific infections, to describe the pathogen profiles of new and repeat clinical cases, and to identify weak links in the herd preventive program. In addition, they may be useful for establishing treatment protocols for subsequent cases. Contrary to the traditional paradigm, culture results from clinical cases are not meant to guide therapy for the current case, but rather for future cases that present with similar cow and quarter characteristics. For example, in a herd situation where 8 of the last 10 clinical case samples grew *E. coli* or nothing, there is a high probability that the next case of clinical mastitis that manifests in a similar manner will also be a coliform infection. Armed with that knowledge, a rapid information-based treatment decision can be made.

### 4 - Bulk Milk Culture

Surveillance systems are most effective when sampling occurs on a regular and frequent basis (Britten, 1996). Many regulatory milk quality programs now sample every tank of milk leaving the dairy farm, although not all samples are necessarily subjected to testing. There have been many attempts to incorporate bulk tank milk culture for mastitis pathogens into herd surveillance and monitoring programs. Unfortunately, evaluations of single and multiple bulk tank cultures have suggested that the media and protocols commonly used are not sensitive enough to correctly identify low prevalence *Staph. aureus* herds (Godkin, 1989). The relative sensitivity of bulk tank culture, compared to composite cow cultures of all milking cows, was 21% for *Strep. ag.*, 9% for *Staph. aureus*, 45% for environmental Streptococci and 37% for coliform pathogens. Newer media and protocols have shown promise in limited application (Ollis, 1995), but have not met with success when evaluated in a diagnostic laboratory (Kelton, 1999). Compared to composite cow cultures, bulk tank milk plated on blood agar or on a modified Baird-Parker medium yielded sensitivities of 33% each. When used in a parallel testing scheme (a positive culture on one or

both media is interpreted as a positive test result), the sensitivity increased to 57%. This represented a marked improvement in sensitivity over previously published results (Godkin, 1989), but still produced far too many false negative test results. The search for a bulk milk tank culturing scheme that is sensitive and specific enough to use as a surveillance tool for detecting changes in the prevalence of *Staph. aureus* in dairy herds continues.

### Summary

An important goal of dairy producers and veterinarians is to maintain high milk quality using a cost-effective, science-based surveillance and monitoring system. SCC remains one of the most cost-effective surveillance systems for mastitis. However, once a problem is detected the challenge of arriving at a definitive diagnosis still remains. Mastitis in cows, regardless of inciting organism, presents with similar signs. Milk culture will always, at some level, need to be incorporated into this system. It is currently the most reliable and cost effective method for identifying the underlying causative agent of the disease process. However, a single culture program will not be uniformly applicable to all herds or herd situations. To resolve a mastitis problem and develop a status monitoring program for a dairy herd three steps need to be taken. First, using all available information there is a need to develop a hypothesis as to the most likely causal pathogen(s) affecting the herd. Confirmation of the cause(s) of the problem must be followed by actions to resolve the situation. Second, the best and most relevant culture system must be implemented to monitor the status of the herd's response to the actions. Data from the status monitor should be assessed for the value of the information that it provides. Third, the entire process must be modified as the disease process, culture results, environmental conditions, level of management and costs dictate.

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