Mastitis and Milk Quality Monitoring in Wisconsin Dairy Herds

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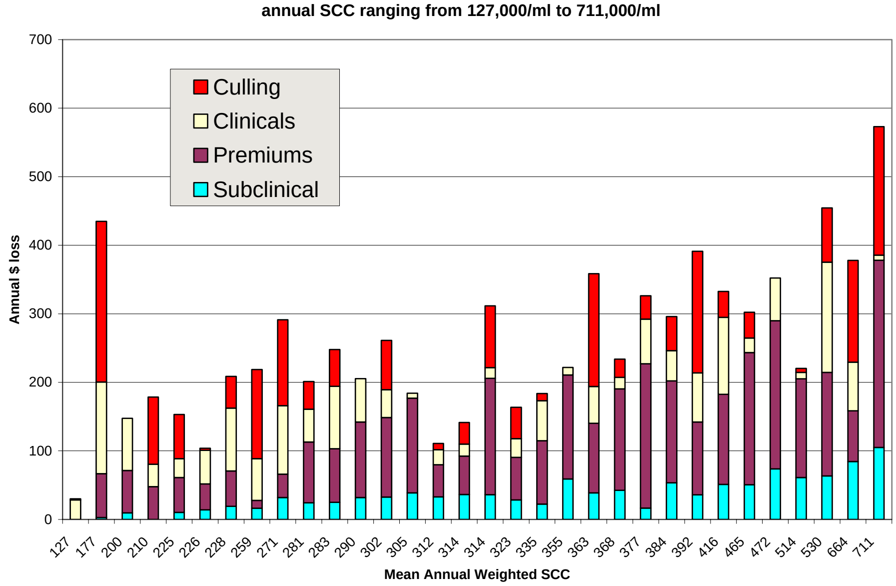
This paper will describe some of the techniques and tools used by the Production Medicine group at the University of Wisconsin-Madison, for the investigation of milk quality and clinical mastitis problems. Our goal is to collect sufficient data and information from herd records and a herd visit to identify the areas on the farm where we will have the greatest impact on the herd problem.

Economics

Historically, DHIA has concentrated on production losses incurred from maintaining chronically infected cows within the herd. However, it is clear that losses in other management areas related to milk quality may be more significant (Figure 1). We have used a modified Nordlund Goal Form (http://www.vetmed.wisc.edu/dms/fapm/forms.htm - Milk Quality) to assess farm losses in four main areas:

- Sub-clinical Losses - using goal linear scores of 2.0 for heifers and 2.5 for mature cows
- Premium Losses – for annual mean bulk tank SCC compared to a 150,000/ml target
- Clinical Mastitis Losses – compared to a goal case rate of 20 quarter cases/100 cows/year at a cost of $90 per case
- Culling Losses – compared to a goal level of culling for milk quality reasons of 5% of the rolling annual herd size

Figure 1: Comparison of milk quality losses by reason for 32 herds with weighted mean annual SCC ranging from 127,000/ml to 711,000/ml



Sub-clinical losses are actually the smallest part of total milk quality losses, accounting for only 14% of the total on average. Premium losses for SCC are by far the most significant in

Wisconsin, accounting for 41% of total losses. Clinical treatments (21%) and mastitis reason culling (24%) are also extremely significant. For the last 32 herds visited, with a mean annual SCC of 344,000/ml, the mean total losses per cow per year have averaged $257 per cow. Note the wide range in milk quality management strategies between farms at similar weighted SCC. Although there is certainly a trend for greater losses at higher SCC, there are some interesting exceptions.

Identifying loss areas in this way has proven to be a powerful tool for understanding management strategies on different farms and for selling improvements.

Udder Pathogens

Recent research into the epidemiology of mastitis pathogens – particularly the environmental bacteria, has shed light on how and when new infections occur, but has further confused the classification of pathogens into contagious and environmental categories.

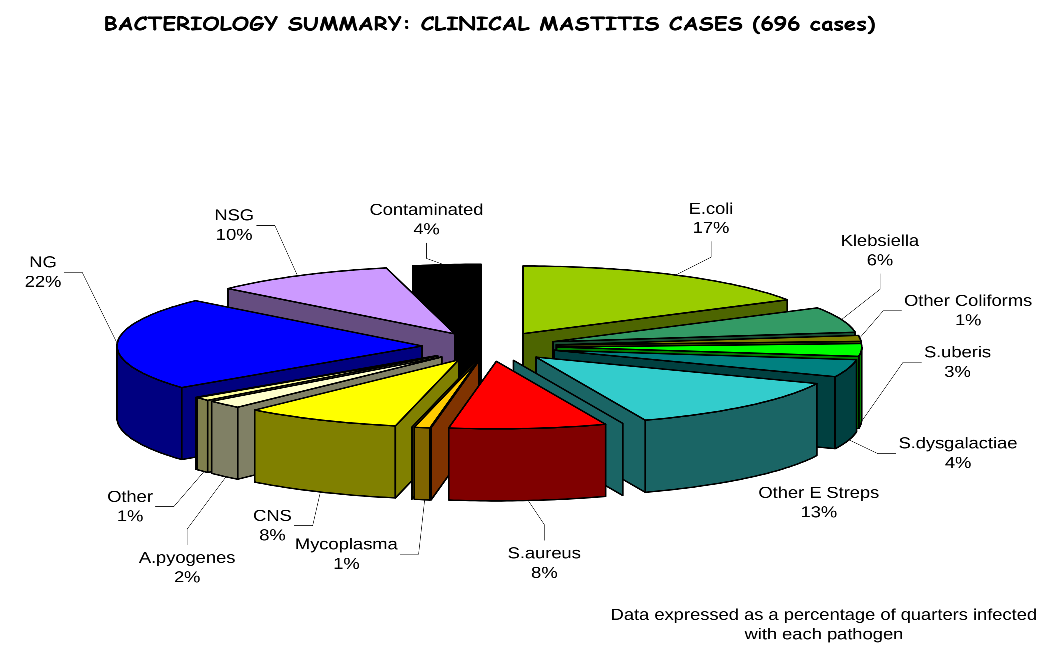
S.agalactiae, S.aureus and *Mycoplasma* are contagious mastitis pathogens, where the udder is the primary reservoir of infection on the farm. The primary role for bulk tank culture is to screen for the presence of these pathogens.

The interpretation of counts of environmental bacteria in bulk tanks is difficult, they may enter the milk from the teat surface, the machine and from the udder itself. Undoubtedly, the primary reservoir of infection for *E.coli* is the environment in which we place the cow – not just the lactating cow, but non-lactating cows and heifers also. However, we are becoming aware that some cows are susceptible to recurrent bouts of new *E.coli* infections and other infections may become chronic and cause recurrent mastitis in an infected quarter. Streptococcal infections, such as *S.uberis, S.dysgalactiae* and *Enterococci,* also come primarily from the environment, but cow to cow spread may also be possible when certain strains and chronic infections occur. In many herds, the numbers of non-agalactiae streptococci and coliforms in the bulk tank culture relate more to chronic udder infections than to teat hygiene. During a mastitis investigation it therefore becomes important to be aware not only of the types of pathogens causing both clinical and chronic intramammary infections, but also to identify the population(s) at risk of new infection and the major risk factors that they are exposed to.

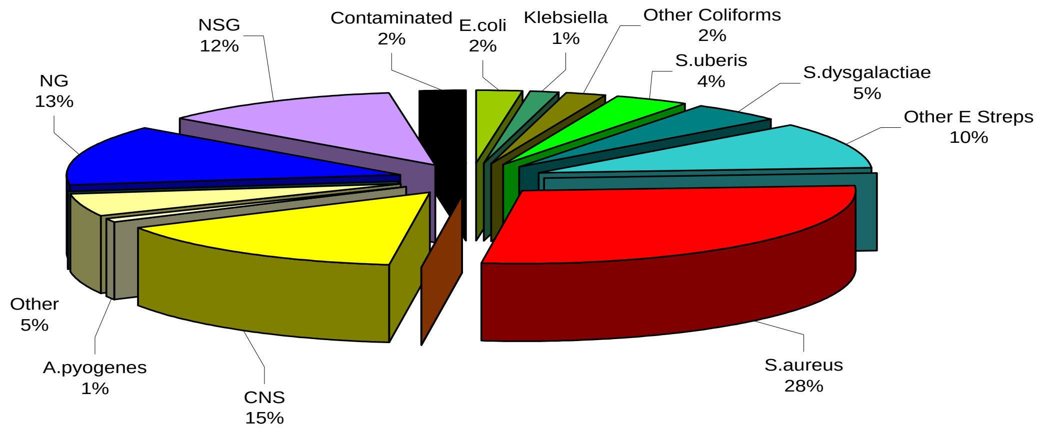
Typically, we send sample vials out to the farm 2-4 weeks prior to the herd visit, with instructions to collect milk from clinical mastitis quarters. On the day of the visit, we quarter sample chronic cows >200,000 for the last three tests.

Results from 221 chronic cows and 696 clinical quarters from herds visited in the last three years are summarized in the pie charts below (Figure 2).

Figure 2: Bacteriology results from clinical mastitis quarter samples and samples from chronic cows >200,000 SCC for at least 3 tests.



BACTERIOLOGY SUMMARY: CHRONIC HIGH SCC COWS (221 cows)



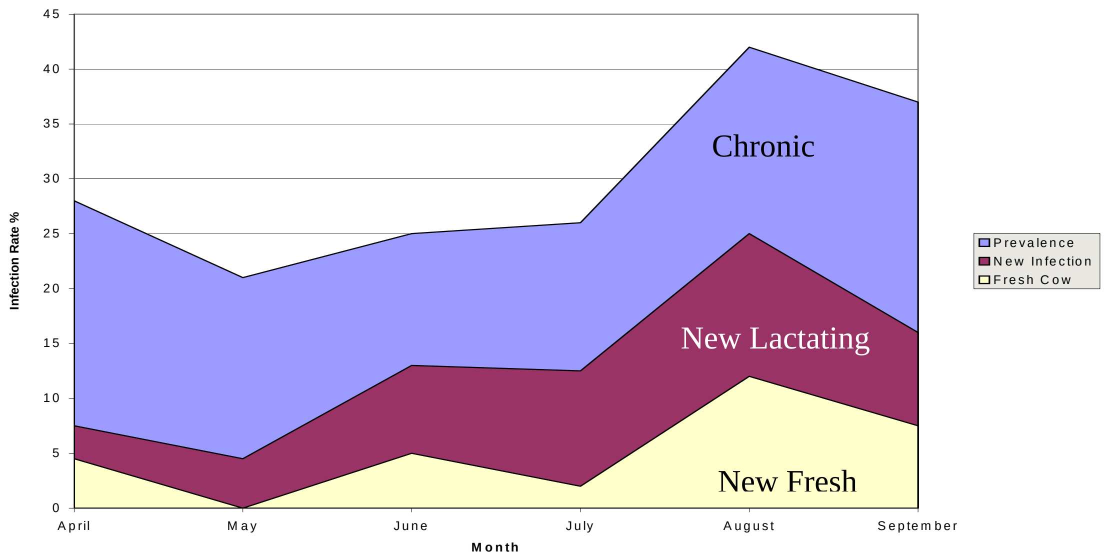
Data expressed as a percentage of chronic cows (minimum 3 SCC tests >200,000) infected in at least one quarter with the recorded udder pathogen.

Population at Risk

We routinely identify the population at risk using WisGraph® – an Excel spreadsheet which downloads DHIA information directly via modem. Individual cow SCC data for the current and previous six months is captured and using 200,000/ml as the SCC threshold determining infection and non-infection, a number of udder infection parameters are calculated.

Figure 3 shows an example herd WisGraph® charting the variation in infection prevalence, new infection rate in lactating cows beyond first test and the contribution of new infections resulting from cows and heifers freshening with a first test SCC > 200,000/ml. The difference between new infections and prevalence represents the chronic population of cows >200,000/ml for 2 or more tests.

Figure 3. Monthly infection prevalence rate, lactating cow new infection rate and fresh cow new infection rate for an example 45 cow herd



The graph presents the data as a proportion of the herd (although the calculated values for new infection rates use different denominators) and can be used to explain to the farmer where the infections are occurring and what proportion of the herd is chronically infected.

The presentation of udder infection rate data using WisGraph® is only available in Wisconsin at present. However, the concepts of analysis used can be replicated in many other farm programs. The system has been invaluable on herd investigations where identification of the population of cows at risk, combined with strategic milk sampling and culture of cows, have facilitated the identification of the most important areas on the farm for milk quality improvements.

Clinical Mastitis Records

Ideally we should calculate lactational rates of clinical mastitis on a quarter basis. However, we currently do not have programs capable of presenting data in this manner. Paper records and DC305 data may be filed out and summarized using another Excel spreadsheet called WisMast.

DC305 records and summarizes only cow case events, and does not screen out repeat entries within a few days of the original event. The definition of clinical mastitis warrants identification of each quarter case occurring within some set period of time – I have suggested a 7 day interval, after which the farmer must make a conscious decision whether to re-treat or continue treatment after label therapy and milk withdrawal. Others use intervals of 14-21 days. The data will usually include all events recorded over a period of one year, across lactations. We calculate quarter cases and cow cases / 100 cows, % herd affected with at least one quarter case and treatment failure rate – quarters treated again after a minimum of 7 days. Mean data from 23 herds with reliable mastitis records are presented in Table 1.

Table 1. Clinical Mastitis Rates in 23 Wisconsin Dairy Herds

Annual Mean	Weighted SCC	Quarter Cases / 100 cows / year	% Herd Affected	% Treatment Failure
23 Herds	340	75	37	13

Clinical rates in excess of the target 20 quarter cases per 100 cows per year are common on the farms visited.

The Herd Visit

The investigation is divided into four main areas:

1. Milking Machine Assessment
2. Milking Routine Assessment and cow responses to milking
3. Housing Assessment
4. Treatment and Prevention Protocols

1. Milking Machine Assessment

If time allows, the machine is tested according to NMC standards between milkings. In many 3X milking herds, the test is limited to pulsator testing, a unit drop test for the assessment of variable frequency drive (VFD) response time, and measurement of claw vacuum using a flow simulator set to 3.6L and 5.5L/min flow. During milking, mean peak flow claw vacuum is measured for at least 10 cows. We require that >90% of cows are milked at less than 42KPa and 100% of cows are milked at >35KPa.

Regulation efficiency problems are still common in hi-line stanchion barn systems, due to a combination of poor regulator maintenance and pipe-work problems. In larger herds, the commonest problems are slow reaction VFD units – taking more than 5 seconds to return the system to stable vacuum after a unit drop off test. It is also not uncommon to find 30% of cows or more milked in excess of 42KPa at peak flow. This is associated with poor milk let down – especially in heifer groups and high vacuum settings at the receiver.

Recently we have taken greater interest in liner types – often we find a mis-match between the liner used and the claw vacuum in operation. Current thoughts are that we aim for a claw vacuum of 40KPa and use a liner with quite a high collapse pressure of around 18KPa. This combination provides rapid milk out, short unit on times and places less pressure on the teat end during massage, which is believed to reduce hyperkeratosis.

2. Milking Routine Assessment

The milking procedure, in terms of preparation sequence and number of cows, is identified, along with any variations in the protocol. Milkers are each assessed for fore-milking, dip coverage, teat wiping, glove hygiene, unit alignment and correction of liner slips.

Times from stimulation to unit application, dip contact and total milking unit on time are collected for individual cows and turn time data are also collected. Cows timed are subjected to an assessment of residual milk – primarily to detect overmilking (defined as <250cc milk remaining per cow). We calculate pen means and proportions greater than targets of 60sec dip contact and 90sec stimulation to unit on time.

Changes to the milking routine are not made lightly – if the data suggests a change, we create a new routine based on speed of workers, location of dippers and try to accommodate some milker preferences. We translate the routine into Spanish explaining why each change is necessary and then act out the routine with the lead milker involved as much as possible.

At least 25% of the herd is teat scored using the system suggested by Teat Club International – scoring teats at unit removal for hyperkeratosis, color, edema, and other lesions (http://www.vetmed.wisc.edu/dms/fapm/forms.htm - Milk Quality). We calculate proportions of teats scoring each level of hyperkeratosis (normal, smooth, rough and very rough) and proportion of unpigmented teats with color change. Targets and means from data collected from 29 herds are given in Table 2.

Table 2. Proportion of Teats Scoring each Hyperkeratosis category for 29 Wisconsin Herds

	Normal	Smooth	Rough	Very Rough
Mean	27	50	26	9
Best 25% Cut-point	32	56	18	2
Worst 25% Cut-point	22	44	37	13

We commonly find hyperkeratosis worse during the winter and early spring months, worse in late lactation and in treatment pens. Red teats are commonly associated with teat pain at unit removal, peak flow claw vacuums greater than 42KPa and high clinical case rates. We don't necessarily see both red teats and hyperkeratosis together, as the latter appears more related to weather conditions and long unit on times than to claw vacuum per se.

3. Housing Assessment

Both lactating and non-lactating cows and heifers are hygiene scored using a four point system (www.vetmed.wisc.edu/dms/fapm/forms.htm - Hygiene), scoring each cow in three zones – the udder, the lower leg and the upper leg and flank. For each zone, we calculate the proportion of scores 3 and 4. Typically, all of the milking cows in a tiestall barn and 25% of the cows in each pen in a freestall barn are scored. Data is presented by pen in order to make direct comparisons between groups on the farm. We often see the worst scores in a freestall barn in pens which are overstocked, in first lactation heifer pens and in breeding pens. We also make comparisons with benchmarks derived from previous herd investigations (Table 3).

Table 3. Proportion of Zones Scoring 3 and 4 for 40 Wisconsin herds

	Proportion of Scores 3 and 4		
	Udder	Lower Leg	Upper Leg and Flank
Freestall Mean	21	58	16
Best Zone Score	5	24	0
Tiestall Mean	18	27	24
Best Zone Score	0	9	5

Stocking densities and their variability are recorded and freestalls are assessed using the Flowchart system described by Nordlund and Cook (2003). Where necessary, bedding samples are taken to assess bacterial load. For both sand and organic bedding materials the coliform count is most useful to monitor and we use a target of <1 million CFU/ml for used bedding.

For organic bedding materials we recommend an all in all out system every 24 hours. More than this and the bacterial load exceeds target levels even when the material appears grossly normal. For sand, we recommend fresh sand be added every 7 days. In several farms, we have removed tires from stalls and now remove all of the sand from the stall to a depth of 12" every 6 months to a year.

4. Treatment and Prevention Protocols

Clinical treatment is assessed in a variety of different ways, including protocol compliance, Treatment Failure Rate (target <12%), days to clinical cure, days out of tank and SCC cure rates where data are available. We merge clinical case data with individual cow SCC data in order to examine treatment success in three main groups of cows:

- Cows clinical prior to first DHI test

- Cows <200,000 the test before clinical
- Cows >200,000 the test before clinical

Treatment success is determined at the two SCC tests after the clinical event. Cure is defined as return to a SCC <200,000/ml at either the first or second SCC test after the clinical event. Cumulative Cure Rate (CCR) is calculated according to the following equation:

$$CCR = \frac{\text{Number of cows cured at } 1^{st} \text{ SCC test + Number cows cured at } 2^{nd} \text{ SCC test}}{\text{Number of cow cases of mastitis}}$$

Table 4. SCC cure data for 10 Wisconsin Herds

SCC Status at Previous DHIA Test	Cumulative Cure Rate (%)	
	Mean 10 herds	Target
Fresh cows before 1st test	58	75
<200,000 previous test	68	75
>200,000 previous test	32	45

These data confirm that we achieve poor cure rates, despite a wide range of treatment protocols for cows >200,000 SCC before becoming clinical. Alternative strategies are required for these cows. In herds with poor recognition of clinical mastitis greater than 50% of all clinical mastitis treated may belong to the >200,000 group. Cure rates will be poor in these herds and many will be using pharmaceuticals inappropriately because of their dissatisfaction with treatment response. The solution for these herds is to improve mastitis detection rates and treat clinical cases earlier.

E.coli vaccination protocols and SOPs for dry off procedure and treatment are examined and observed if time allows.

The Action Plan

Having identified the population at risk, determined the udder pathogens involved and identified the various areas on the farm that would be considered sub-optimal, an action plan is devised aimed at targeting the areas of greatest impact. We rarely recommend more than six changes.

All reports are accompanied by a visit back to the farm, and a meeting with the herd owners, veterinarian and any other interested parties usually takes about 2 hours. This is an essential part of the service in my view and avoids any misunderstanding gained from just reading the report.