

Myth: High SCC is always problematic (or is it?)

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Abstract

For decades monthly somatic cell counts (SCC) have been used to assess udder health of dairy cows to classify cows as acutely or chronically infected, or not. However, with the introduction of technologies that measure SCC daily, dairy producers and veterinarians have access to information that is more current, but also more volatile. Is there a need to re-think our use of SCC?

Key words: dairy, SCC

Résumé

Le comptage des cellules somatiques (CCS) mensuel a été utilisé depuis des décennies pour évaluer la santé du pis chez les vaches laitières et déterminer si la vache est infectée de façon *aiguë* ou chronique, ou pas. Toutefois, grâce aux nouvelles technologies qui permettent un comptage quotidien, les producteurs laitiers et les vétérinaires ont accès à de l'information qui est plus à jour mais aussi plus volatile. Existe-t-il un besoin de repenser notre utilisation du CCS?

Introduction

Milk somatic cells are comprised of leukocytes and mammary epithelial cells, with the leukocytes being of most interest with respect to intramammary infection (IMI). In the uninfected mammary gland, macrophages are the predominant cell type, while in infected quarters neutrophils can comprise up to 99% of the cells present. These leukocytes serve a variety of roles including surveillance and response as part of the cow's innate immune system.

Counts of somatic cells in milk from quarter, cow composite, and bulk-tank samples are commonly used as indirect measures of udder health and milk quality. At the cow composite level, the threshold of 200,000 cells/mL is commonly used to designate the mammary gland of multiparous cows as infected or not.⁴ At the bulk tank level, the threshold of 400,000 cells/mL is used in many jurisdictions as the threshold for applying milk quality penalties. Traditionally, the interpretation and response to change in somatic cell count (SCC) has been based on periodic measurements. For herds enrolled in milk recording programs, cow composite SCC's are available monthly, while bulk-tank cell counts have until fairly recently been reported on a monthly or weekly basis. With an increase in emphasis on food quality and safety, many milk buyers now provide bulk-tank SCC's for every load of milk that leaves the farm. Similarly, with the introduction of

on-farm precision technologies, many herds have access to equipment that can provide a SCC value or estimate for each cow at every milking. The challenge for both the producer and the veterinarian is how to utilize these more frequent measures of SCC while balancing a desire to intervene quickly to mitigate negative consequences without over reacting and potentially treating cows that do not need treatment.

Consequences of Increased SCC

The consequences of increased SCC accrue at both the herd and the cow level. It is well established that milk quality, as measured by SCC, has a significant impact on the yield, quality, and shelf-life of dairy products³, and as a result some milk buyers offer a premium for milk below various arbitrary thresholds. At the cow level, Raubertas and Shook¹³ established the negative impact of elevated SCC on milk yield in the early 1980's, and this has been confirmed by others including by Hand et al¹⁰ some 30 years later. This milk loss is greater in multiparous cows, in higher producing cows, and increases as the number of elevated monthly tests increases.

Given the significant consequences associated with elevated SCC, our knowledge regarding the causes of IMI, and the evidence that specific best practices for milk harvest can prevent intramammary infection (IMI),⁶ it is interesting that we consistently see a broad distribution of regional and national SCC's from many North American and European countries around a mean of 200,000 cells/mL. It is clear that geographical location, with its associated temperature, humidity, and availability of bedding materials plays a role. Herd size and pressure to fill fluid milk quotas also plays a role,¹⁵ as does variation in the adoption¹ and consistency² in application of best milk harvest practices. Finally, it appears that while financial incentives to market lower SCC milk are effective in stimulating some dairy producers to take action, others are motivated to apply their limited resources to other areas in the dairy enterprise. It is also clear that some dairy producers chose to believe that very low SCC's are detrimental to their cows, impeding their ability to respond to intramammary challenge.

Can SCC's Get too Low?

The question 'Can SCC's get too low?' has been posed and answered many times over the last quarter century. Reports by Erskine et al⁷ and Green et al⁹ in the late 80's and early 90's that clinical mastitis was higher in herds with lower mean herd SCC likely stimulated some of this discussion. It is clear that the cow's ability to respond to intramammary

challenge is complex and varies with the pathogen.¹⁴ Based on a recent review by Fox⁸, it is not the number of cells that are present in the mammary gland prior to pathogen entry, but rather the number of cells that can be recruited quickly to the gland to meet the challenge. There is evidence that cows with quarter cell counts as low as 20,000 cells/mL are not compromised in their ability to respond to intramammary challenges¹². Given this reality and the knowledge that elevated SCC is associated with lower milk yield and inferior milk product quality, the goal to continue efforts to decrease cow and herd SCC is sound.

Challenges of interpreting daily SCC

Most udder health programs are based on evaluation of monthly cow composite SCC tests carried out by milk recording agencies. Using a cut-off of 200,000 to 250,000 (and perhaps 150,000 for heifers) cells/mL, cows are classified as infected or uninfected on that test day. It is well established that this system is imperfect (sensitivity estimates range from 25% to 77%; specificity estimates range from 62 to 100%¹¹), resulting in significant numbers of cows with false-positive or false-negative interpretations. Adjusting the current SCC test results with results from previous test days only increased the test performance slightly¹¹. Using sequential test day results (approximately 30 to 40 days apart), cows are often further classified as being uninfected, cured or having new infections or chronic infections. Work by Dufour and Dohoo⁶ suggests that there are limitations to the predictive value of changes in sequential monthly composite SCC to identify incident IMI.

With the introduction of on-farm precision technologies, many herds have access to equipment that can provide a SCC value or estimate for each cow at every milking. An example of daily SCC data from 1 cow over a 4-month period is presented in Figure 1. Examination of similar data from cows

in several herds generates more questions than answers, and challenges some of our baseline assumptions.

In Figure 1 there is a short spike in cow composite SCC from a baseline of less than 40,000 cells/mL to over 600,000 cells/mL. Within 2 days the cell count is back to under 40,000 cells/mL and remains at that level for the next month. There are at least 3 potential explanations for this SCC spike:

1. This could represent an error in animal identification either at the farm or the milk testing laboratory, and it is possible that this SCC value belonged to another cow and was attributed to this cow by mistake.
2. This elevation in SCC could be due to carry-over of milk with a very high SCC content either from a cow milked prior to this cow using the same milking unit on the farm, or during pipetting of milk samples in the milk recording laboratory.
3. This could represent a challenge to the mammary gland of this cow, during which bacteria or another foreign substance was introduced into the mammary gland during or after milking, and produced an influx of leukocytes to clear the gland. With the challenge resolved, an IMI was not established and the SCC returned to the baseline.

Unfortunately there are no culture data to either support or refute any of these interpretations, so the observer is left to wonder. It is clear, however, that this elevation in SCC did not warrant treatment of the cow or quarter, and that administering treatment would have been at best a waste of time and money. If one accepts the third possibility, then this is a clear example of a cow's immune system responding, as it should to clear a challenge, and is in fact an example where a transient elevation in SCC is good. One could also argue that this is an event that does not warrant a producer warning or alarm.

Also in Figure 1 the cow experiences a small rise in SCC at the end of February, and this is followed by almost 1 month

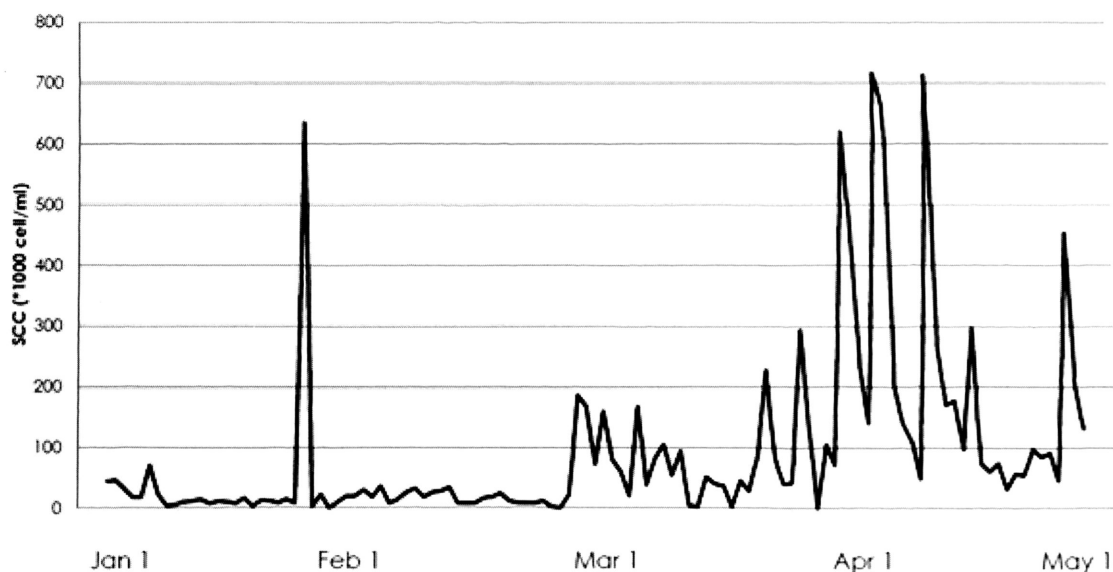
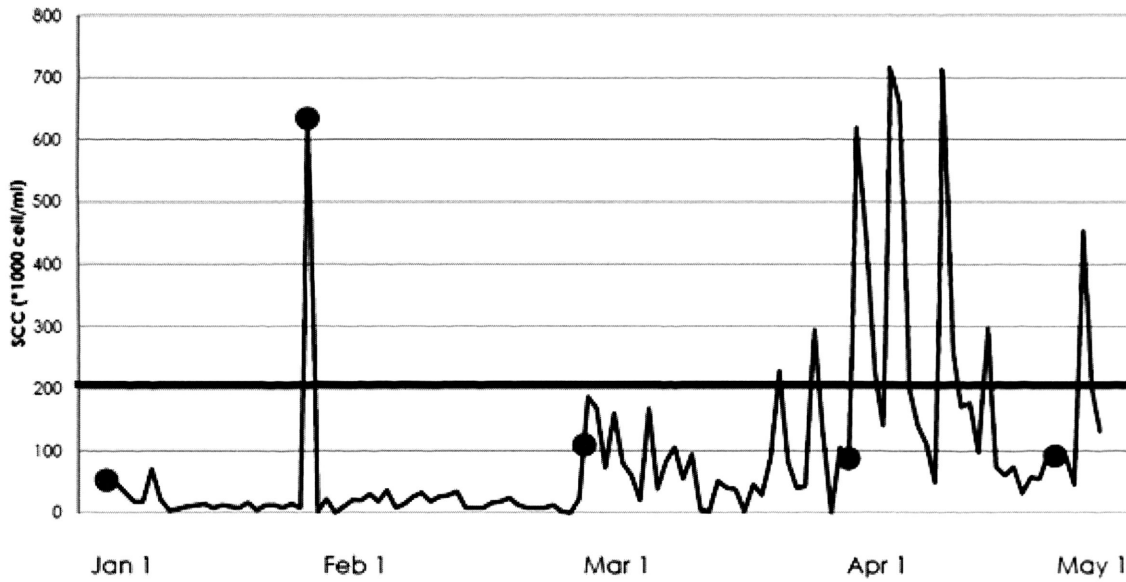


Figure 1. Daily somatic cell count for one cow over a 4 month period.

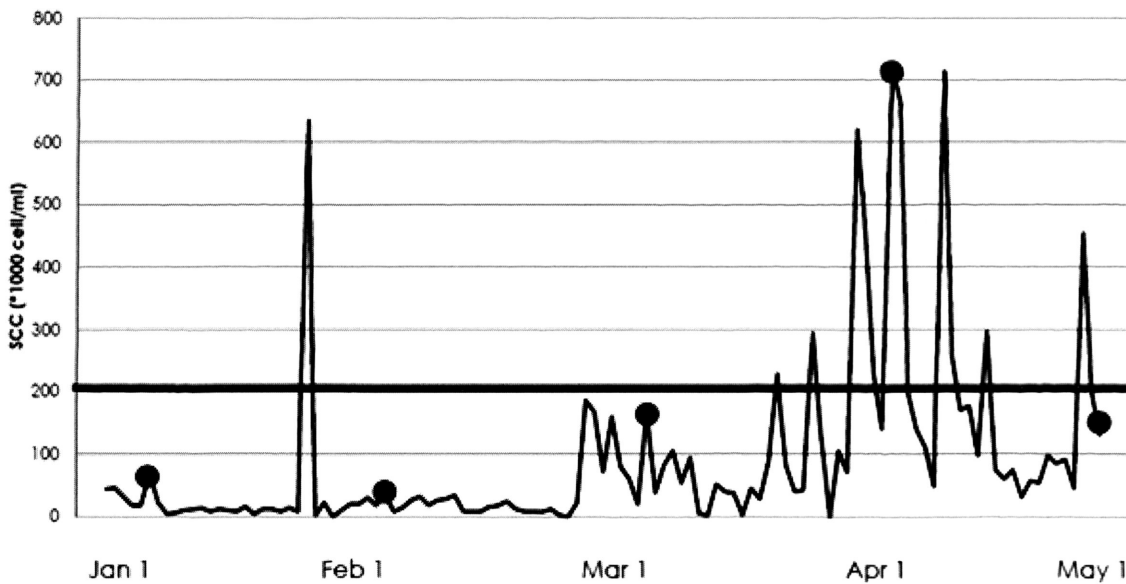
of SCC fluctuations between 50,000 cells/mL and 180,000 cells/mL. It is likely that there is some repeated challenge, and perhaps infection becoming established in 1 or more quarters, yet at no time during that month does the SCC rise above 200,000 cells/mL, and so the cow would not be classified as having an IMI. By the end of March and through most of April the SCC fluctuates quite dramatically between 50,000 cells/mL and over 700,000 cells/mL, yet changes in the milk to signal a clinical case of mastitis was never detected. Once again, without milk culture data it is difficult to definitively state that this is an established, and perhaps chronic, IMI in 1 or more quarters. Nonetheless, it begs the question whether this cow might benefit from antibiotic treatment, and whether

earlier treatment in March might have increased the probability of cure. One might speculate that this pattern could be consistent with the slow establishment of a *Staph aureus* infection with relatively low bacterial numbers that stimulate a modest immune response in the mammary gland.¹⁴

Figure 2 represents 2 different scenarios in which the traditional monthly milk recording schedule is imposed on these daily SCC data. In Figure 2a the cow would have been classified as having a new infection at the second test in late January, then a cure at the third test in late February, and uninfected at the fourth and fifth tests. This is likely the worst scenario, as the 'new infection' at the second test is likely a false-positive, and the failure to detect the developing sub-



a) 30 to 37 day test intervals starting on December 23.



b) 30 to 37 day test intervals starting on January 3.

Figure 2. Examples to illustrate the impact of daily changes in cow composite SCC on interpretation of monthly milk test SCC. Each black dot represents the monthly SCC test, and the horizontal line represents the cut-point of 200,000 cells/mL used to classify the cow as infected or uninfected.

clinical IMI at the third, fourth and fifth tests are potentially costly false-negatives. In Figure 2b the cow is considered uninfected at the first 3 tests, is classified as a new infection at the fourth test, and then cured at the fifth test. Missing the short spike in late January is likely not a problem, but the use of the 200,000 cell/mL cut point for defining IMI resulted in a 1-month delay in identifying a new IMI.

The challenges of using the daily SCC data and deciding when it is appropriate to intervene with treatment and when to allow the cow's immune system to handle the insult are considerable. Attempts have been made to create decision support models that minimize false positive alarms, while signaling the development of a new IMI as soon as possible. Chagunda et al⁴ developed a model for detection of cow mastitis based on changes in lactate dehydrogenase that had a sensitivity of 82% and specificity of 99% for detecting clinical mastitis, but did not evaluate the algorithm for detection of subclinical IMI. Sorensen et al¹⁶ developed a model for mastitis detection based on automated frequent inline SCC testing with an aim of minimizing false positive alarms, but found that the model detected less than half of the detected clinical cases. Presently, good decision algorithms for utilizing the more frequent SCC data are lacking.

Given the significant impact of milk quality on product quality, many milk buyers measure SCC's for every load of milk that leaves the farm, and make the test results available to their farmer clients, presumably so that corrective action can be taken as soon as possible when the SCC begins to rise. The challenge is when to most effectively intervene, and at what threshold. There is very little in the published literature to guide this decision process, given the multitude of factors that can influence bulk-tank SCC, especially in smaller herds. One process that is used to effect a short-term solution is to use milk recording SCC reports to withhold high SCC cows from the tank. However, the delay in accessing test day SCC results and high volatility in cow SCC as illustrated in Figure 1, renders this approach generally ineffective.

Conclusions

There is plenty of evidence that low SCC's are good for cow health, for milk yield, and for milk product quality. There is little evidence that low SCC's place the cow at a disadvantage for responding to intramammary challenge. There is more daily volatility in cow composite SCC than many of us have traditionally considered, and in many cases very short spikes in SCC are simply indications that the cow's

immune system in responding to a challenge normally. Use and interpretation of monthly milk recording SCC to classify cows as infected or not generates substantial numbers of false-positives and false-negatives, however good, accurate and timely decision algorithms to utilize more frequent SCC's are lacking.

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