Three Ways to Lose Money on the Farm: A View from the Udder

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Take Home Messages

Three things to improve the bottom line for dairy producers:

- Properly stimulate teats before milking to reduce bimodal milk letdown.
- Maintain and properly operate automated cluster removers (automatic take-offs) to reduce overmilking.
- Use individual cow somatic cell counts rather than bulk tank or herd average somatic cell counts to monitor subclinical mastitis in a herd.. New infection rates and proportion of infected cows are key indicators, especially for early lactation cows.

Milking Efficiency: Udder Prep and Bimodal Milking

A large majority of dairy farms routinely evaluate and maintain milking equipment; however, milking efficiency should be considered from two other points: the amount of time the milking cluster is attached to the udder (unit on time) and the percent of unit on time that milk flow is near maximum. When milk isn't flowing while the unit is attached, the unit is inefficient, and more importantly, it damages the teat tissue, which may increase the risk of mastitis and decrease milk yield. Two problems that lead to poor milking efficiency are milking routines that don't achieve consistent milk letdown and overmilking. Either one of these problems can leave cows 'high and dry' for a period of time, and expose teats to high vacuum levels. In this section, I will discuss poor milk letdown or what is called bimodal milking.

When teats are being stimulated before milking, nerves carry an 'electric signal' to the brain. The brain then releases oxytocin into the blood which travels to the udder. It takes about one to two minutes for oxytocin levels to increase in blood to optimally facilitate milk letdown toward the teats. The two important points for oxytocin release are sufficient stimulation (at least 10 seconds of actual physical touching) of the teats and the duration of the latency period, that is, the time interval between when teats are first stimulated until the cluster is attached. Unfortunately, with increasing herd size, the number of cows that can be milked through the parlour per hour, or parlour turnover rate, is thought by many dairy producers to be a choke point of profitability. Thus, parlour efficiency is emphasized at the expense of milking efficiency.

How would you know if your routine is minimizing bimodal milking? One method is to measure milk flow with digital vacuum recorders (VaDia®, Biocontrol NA). VaDia units record vacuum in the mouthpiece chamber (at the opening of the liner) and in the cluster. VaDia units don't measure milk flow directly, but give us a snapshot on milk flow. A simple way to interpret VaDia results relative to milk flow is:

High Milk Flow = Low vacuum in the liner or cluster
Low Milk Flow = High vacuum in the liner or cluster

VaDia units measure vacuum levels at four different places on the cluster simultaneously: front and rear liners, near the cluster, and in a short pulsation tube (Figure 1).

Figure 1: VaDia units measure vacuum in the mouthpiece of a front and rear liner (red arrows), near the cluster (short milk tube, white arrow) and in a short pulsation tube (yellow arrow).

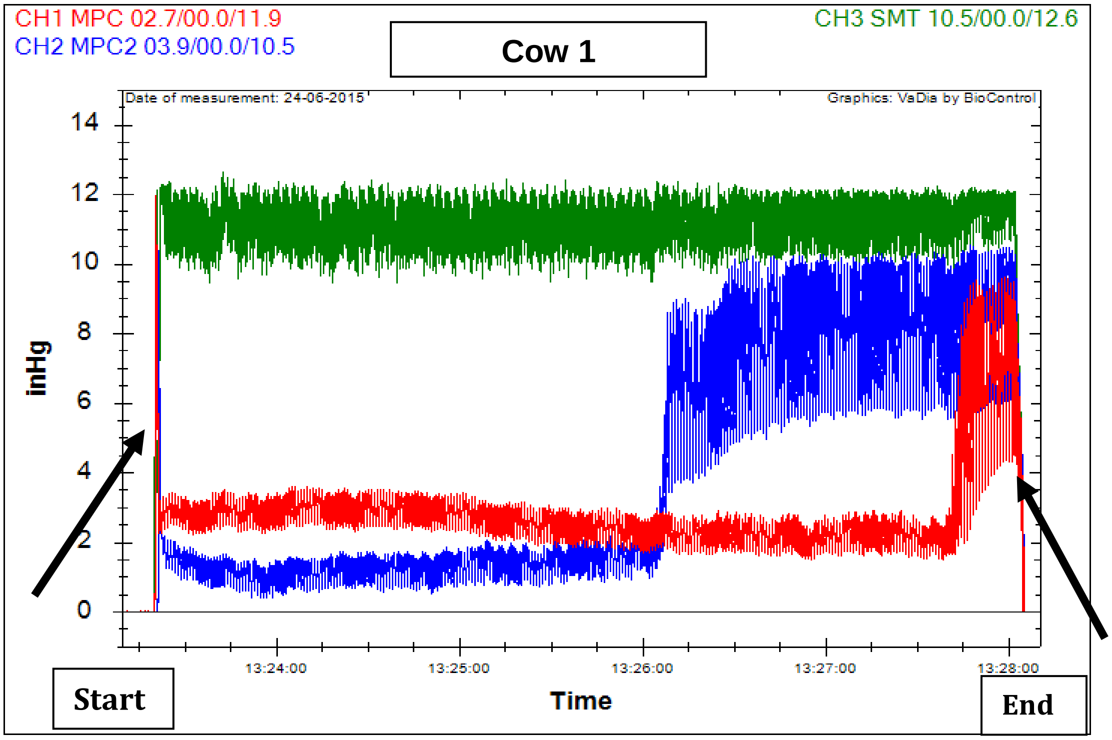

Figure 2: VaDia plot depicting that Cow 1 was ready for milking. Vacuum (red line - rear teat; blue line - front teat; green line - liner mouthpiece and cluster) in liner mouthpiece drops to low level immediately after unit is attached. Cow was ready to milk!!! Arrows on the left and right indicate start and end of milking, respectively.

Figure 2 shows a cow that was ready to milk. The vacuum in the liner mouthpiece near the teat (red and blue lines [lower lines]) dropped quickly (< 10 seconds after the unit was attached) and remained low until each teat was finished milking. The front quarter (blue line) finished before the rear quarter (red line).

What about cow 2 (Figure 3)? Vacuum in the liner mouthpiece and cluster (green line) decreased, but then increased to near maximum levels, and finally decreased again. This cow was not ready to milk, milk flow was low for more than a minute after the milking unit was attached, signifying bimodal milk letdown.

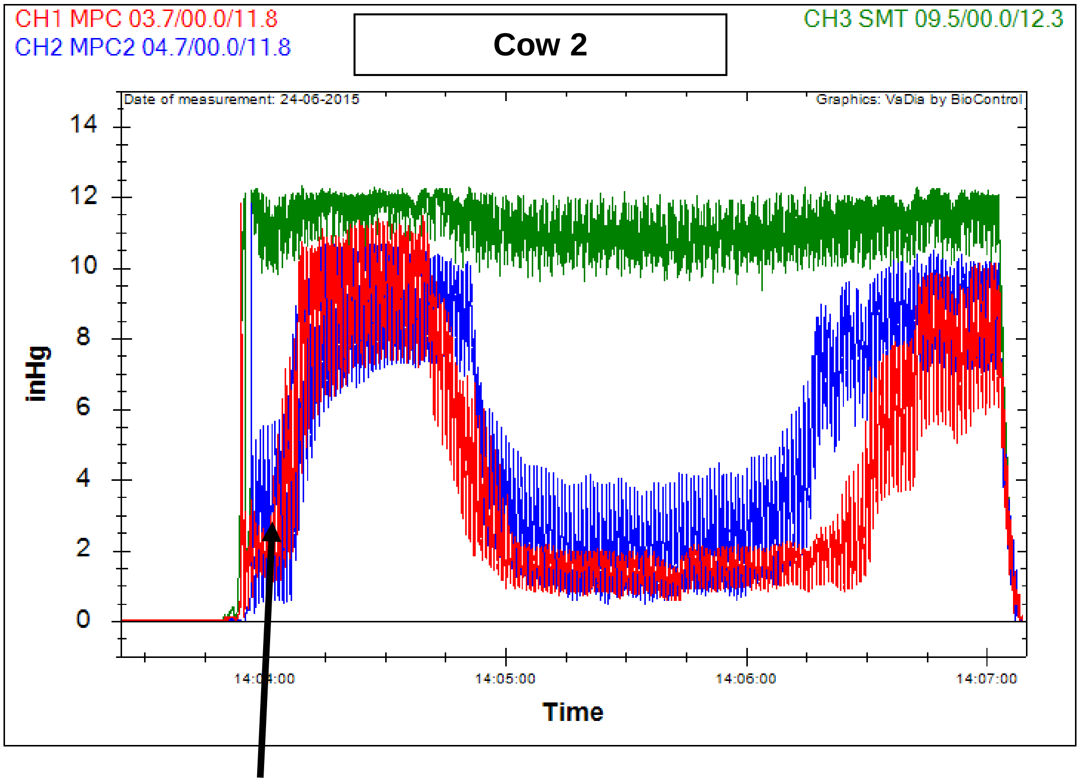

Figure 3: VaDia plot depicting that for Cow 2, vacuum (red line - rear teat; blue line - front teat; green line - liner mouthpiece and cluster) decreased, increased, and then decreased again. This is bimodal milking indicating poor milk letdown.

For information on how VaDia recorders describe milk flow, visit the Quality Milk Alliance article site listed below.

http://qualitymilkalliance.com/2016/01/07/let-the-cows-score-the-milking-protocols/

To view the graphs online, visit the QMA website at these links:

http://qualitymilkalliance.com/2018/05/01/how-is-your-milking-efficiency-part-1/

http://qualitymilkalliance.com/2018/11/13/how-is-your-milking-efficiency-part-2/

So how does bimodal milking relate to milking efficiency? For Cow 1, milk was flowing for about 4 minutes and 30 seconds of the total unit on time of 4 minutes and 45 seconds. Thus, the efficiency of this milking was 95%. For Cow 2, milk was flowing for about 2 minutes of the total 3 minutes and 15 seconds the unit was attached, or a milking efficiency of about 60%. Why does this matter?

When teats are subjected to high vacuum (as in the case for cow 2) blood is congested within the teat and the diameter of the teat canal decreases, which then decreases milk flow (Penry et al., 2018). This can be detrimental to the heath of the teat tissue. Additionally, the longer it takes for milk to start flowing after cluster attachment, the more milk is lost from that milking (Erskine et al., 2019). Cows that have bimodal letdown have the same unit on time as cows that have normal milk letdown. That is, cows that have a poor start to milking don't "catch up" with milk yield by taking longer to milk. This may seem illogical, but the changes that have occurred in the teats from high vacuum result in lower milking efficiency and less milk.

A delay of one minute causes more than a 3 kg loss of milk—in just one milking.

▪ Milking Efficiency: Overmilking

After a milking is completed, the vacuum should be turned off and the cluster removed from the cow as soon as possible. Removal of the units is usually done by automatic detachers (take-offs) that rely on sensors that record milk flow between the cluster and milk pipeline. When milk flow remains at a low level (about 0.2 kg/minute) for a few seconds, the vacuum shuts off and the cluster is detached from the cow. However, if herds lack detachers, or if operators intervene in deciding when a cow is done milking, units may be removed manually. Units should be removed no more than 15 seconds after milking is done and units that stay on more than 30 seconds are considered to be overmilking.

How do you recognize overmilking? A simple way is to hand strip the udder after the unit is detached. A cup of milk should be easily attained without overworking the teats. As mentioned previously, milk flow can also be estimated with digital vacuum recorders.

In the example of Cow 1 above, at the end of milking, although the front quarter was done milking for nearly two minutes before unit take-off, the rear quarter continued to milk until about 15 seconds before unit take-off and thus was not overmilked. Cluster vacuum (green line) continued to fluctuate in a range of about two inches of mercury, or about seven kPa during this time, suggesting milk flow for the cow was continuous.

What about Cow 3 (Figure 4)? Milk flow started soon after cluster attachment, but vacuum in both the front and rear quarters increased to near maximum and plateaued two minutes before unit take-off. Also, the cluster vacuum (green line) increased to maximum vacuum during this time with little variation, which suggests little or no milk flow. This cow was overmilked.

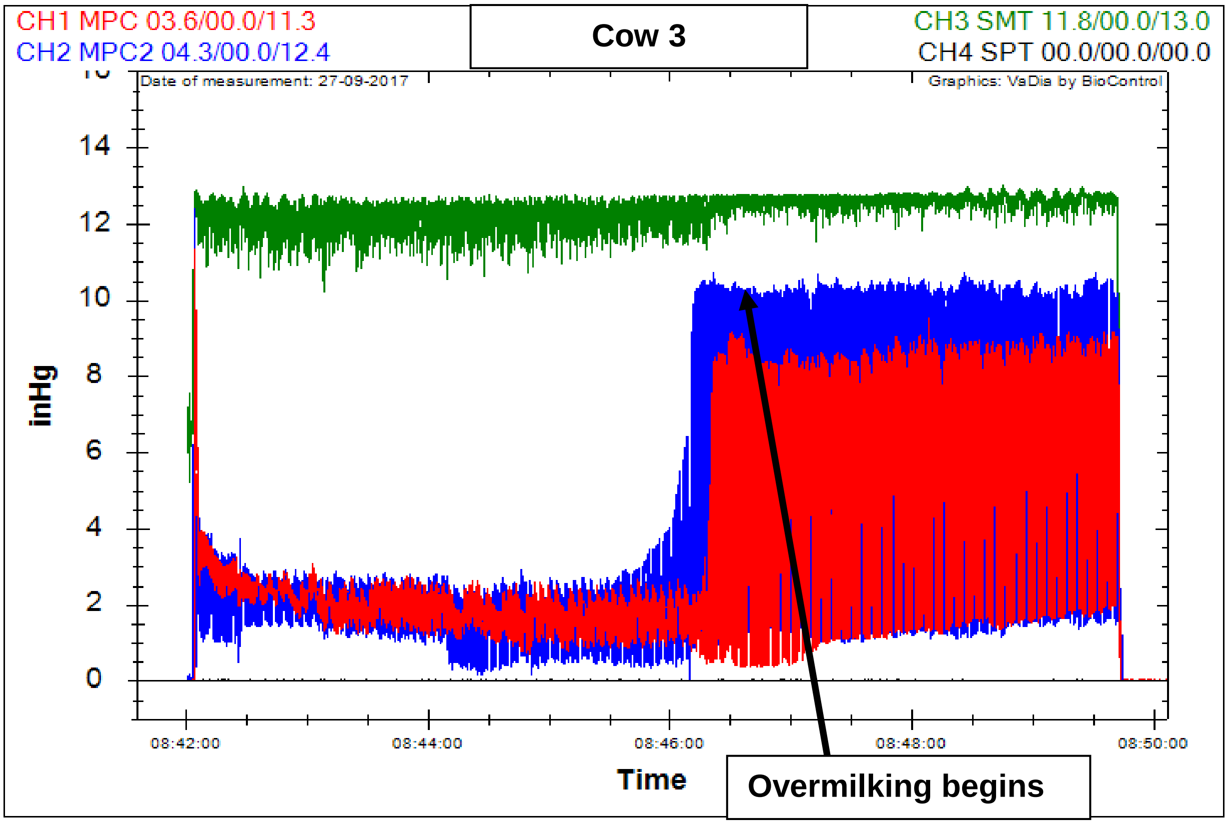

Figure 4: VaDia plot depicting that milk flow started soon after cluster attachment, but vacuum in front and rear quarters (red line - rear teat; blue line - front teat; green line - liner mouthpiece and cluster) increased to near maximum and plateaued 2 minutes before unit take-off. Cluster vacuum (green line) increased to maximum vacuum with little variation, suggesting little or no milk flow. This cow was overmilked.

How does overmilking affect milking efficiency? As described earlier for Cow 1, milk was flowing for about 4 minutes and 30 seconds of the total unit on time of 4 minutes and 45 seconds, or a milking efficiency of about 95%. For Cow 3, milk was flowing for about 4 minutes and 30 seconds of the total milking time of 7 minutes and 30 seconds, or a milking efficiency of about 60%. Why does this matter?

Unnecessary high vacuum is never good for teat health. Additionally, overmilked cows have long unit on-times. This reduces cow throughput in the parlour and extends the length of time needed to milk a herd. Also, slower parlour efficiency requires cows to stand in the holding pen and parlour for longer periods of time, reducing the time they spend resting and eating.

Reducing overmilking and decreasing unit on time by just a couple of minutes per cow decreases the duration of a milking shift by at least 45 minutes in a 400 cow dairy, or the total milking time by about two hours per day for a three times-a-day milking herd.

The most common causes of overmilking are lack of automatic detachers, automatic detachers that are not operating properly, or the tendency to have milking operators place the auto-detach mode to manual. This often occurs when operators are frustrated with detachers that aren't functioning well, or the mistaken belief that cows need to be milked out dry. Cow 4 (Figure 5) is a VaDia plot of overmilking that occurred from re-attaching the cluster after the cow was done milking. Note the drop in all vacuum lines while the unit was off the cow.

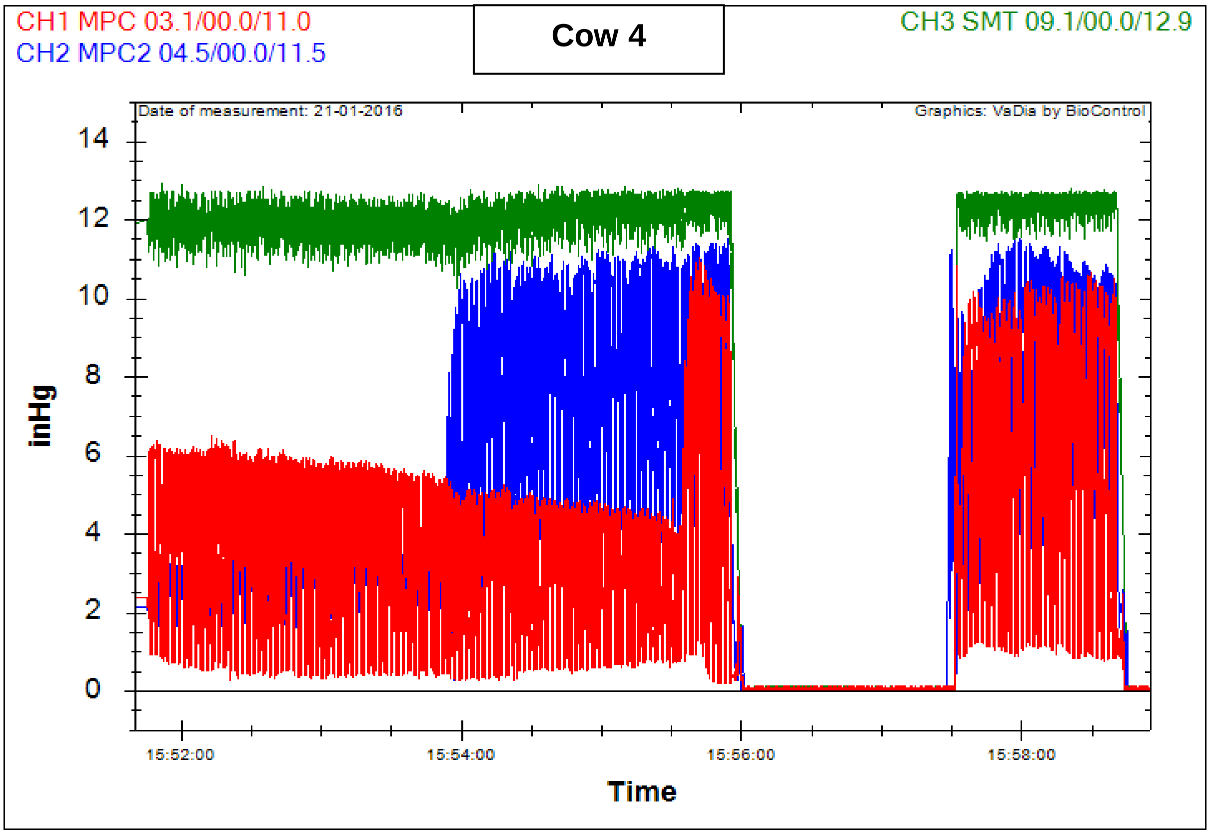

Figure 5: VaDia plot of overmilking that occurred from re-attaching the cluster after the cow was done milking. Note the drop in all vacuum lines while the unit was off the cow.

▪ Herd Average (Bulk Tank) Somatic Cell Counts: The Whole Mastitis Story?

Somatic cell counts (SCC) are excellent indicators of subclinical mastitis. Somatic cells are mostly leukocytes (white blood cells), and they increase in milk almost entirely because of microbial infections. Thus, SCC are used widely by dairy producers and processors as a measure of milk quality. Higher SCC in milk decreases shelf life in the grocery store and decreases yields of cultured dairy foods such as cheese.

Dairy producers routinely use bulk tank (or DHI average) SCC to track mastitis in their herd. There is a strong correlation between the higher proportion of infected cows (mastitis) and herd SCC, and an increase in herd SCC equates to lost production of milk. Herds with SCC that are consistently below 150,000 cells/mL will have less than 15% of their cows infected with subclinical mastitis, whereas herds with SCC consistently near 500,000 cells/mL will have nearly half of their cows with mastitis. But interpreting the level of mastitis in a herd using herd SCC from bulk tanks or DHIA records requires a little insight. The key words for this interpretation are consistent and average.

Herd SCC can vary from day to day and week to week. Additionally, bulk tank SCC are not indicative of the entire mastitis picture because treated cows with clinical mastitis may have their milk withheld from market because of drug residue concerns; thus, they do not contribute to the herd bulk tank SCC. Bulk tank SCC rely on two factors: the number of cells and the kg of milk that each cow yields into the milk supply. Thus, cows that are higher milk producers than their herd mates will contribute more to the herd SCC. High-producing cows with low SCC are beneficial for herd milk quality, but high producing cows with mastitis will have a negative impact on herd milk quality.

Table 1 lists the percent of the total herd SCC (weighted DHI average) that is contributed by (1) the three highest SCC cows in each herd, or (2) the top 2% (highest SCC) of cows in each herd for 50 dairy farms from Michigan, Ohio, Indiana, and Pennsylvania. The data are further divided into herds with less than 200 cows (18 herds), 200 to 499 cows (20 herds), and 500 or more cows (12 herds). As would be expected in smaller herds, just three cows with high SCC cows can impact the herd SCC dramatically, averaging 32% of the SCC contribution from all cows in the herd.

As herds get larger, the impact from three individual cows is smaller. However, what does not change with herd size is the impact that just a small percent of the herd (2% of the milking cows) has on the total herd SCC. For example, even in herds with more than 500 milking cows, the highest 2% SCC cows contributed an average of 35% of the total herd SCC.

Whether you are milking 70 or 3,000 cows, herd milk quality is affected by a small proportion of animals.

Table 1. Contribution to total herd SCC (weighted DHIA average) by small populations of cows within herds (n=50 herds). None of the herds had SCC more than 400,000 cells/mL.

	Percent of total herd SCC	
Herd Size (# of milking cows)	**Highest 3 SCC cows in herd**	**Highest 2% SCC cows in herd**
< 200	32	30
201 – 499	22	32
≥ 500	13	35

Consistency must also be considered when using herd-level SCC. Somatic cell counts vary considerably and are affected by daily changes in the herd relative to proportions of fresh cows to cows that are culled or dried off and younger to older animals, cows with infections of long duration, cases of clinical mastitis, and to some extent sampling and laboratory variation.

Care should be used to assess meaningful changes in herd average SCC based solely on one or two months of records. As described in Table 1, all herds can see deviations in SCC from the infection dynamics of just a small percentage of cows. When considered over longer periods of time, herd average SCC correlate well with the number of infected cows within the herd. However, a better indicator of trends in subclinical mastitis is the distribution of individual cow SCC rather than the average herd SCC.

In general, cows with linear SCC scores of 4 or greater are likely to be infected. Thus, a key indicator for milk quality might be to follow the proportion of cows with linear SCC scores of less than 4, or non-infected cows.

Table 2 is a six-month history of a herd with a DHIA herd average SCC that exceeded 400,000 cells/mL. Overall, the herd average SCC trended downwards over the period. However, the overall increase in the percentage of non-infected cows (linear score < 4) was very modest, only 65 to 67%. Additionally, the apparent decline in subclinical mastitis that occurred from month 2 to 3 (as measured by herd SCC decreasing from 334,000 to 281,000 cells/mL), resulted in an increase of infected cows by 5%. Thus, dairy managers and veterinarians should track the distribution of SCC scores as well as average SCC to monitor quality milk.

Table 2. Herd average SCC and individual cow linear SCC score over an 8 month period.

		Linear SCC Score			
Month	**Herd SCC** (cells/mL)	0-3***** (< 142,000)	4 (142-283,000)	5 (284-565,000)	6-9 (>565,000)
---	439,000	65	12	7	16
1	272,000	69	10	9	12
2	334,000	69	11	7	13
3	281,000	64	14	11	11
4	169,000	72	15	8	5
5	243,000	74	11	8	7
6	280,000	67	12	9	12

*Uninfected by DHIA SCC standards

Two key factors determine the percent of infected (mastitis) cows in a herd: 1) the rate of new infections, and 2) the rate of removal of infections from a herd. Herds remove infections by treating cows with antibiotics, culling chronically infected cows, treating cows at dry off, or in some cases, stop milking the affected quarter….choosing to milk the "3 quarter" cow. Drying off a chronically infected quarter is a viable option for removing poor quality milk from the food supply and reduces the risk for the infected quarter to spread the infection to other cows. Drying off a chronically infected quarter is also preferable to repeating antibiotic therapy, which will not likely result in a cure…treating the "chronic offenders". However, is culling cows, drying off quarters, or treating mastitis with antibiotics the best way to maintain lower herd SCC, or is this a game of "whack-a-mole"? If the new infection rate for subclinical mastitis is not lowered while removing infected cows or quarters from the herd, the percent of infected cows essentially remains the same.

Figure 6 shows a scattergram of over 120 herds in the Midwest (mainly from Michigan) where the DHI herd average SCC is plotted against the new infection rate (percent of cows) for each herd. In this case, a new infection was defined as a cow that had a linear SCC score of less than 4 during the previous test date but had a SCC score of 4 or greater at the current test date. As expected, there is a strong correlation between new infection rate and herd average SCC. Within the "blue rectangle" are herds with test date herd average SCC between 100,000 cells/mL and 175,000 cells/mL, a SCC that is below the U.S. national average and an indicator of good milk quality. However, the range of new infection rates in these herds varies from 2% to 15%, a more than seven-fold difference. How can this be happening when the SCC for all these herds is considered to be very good?

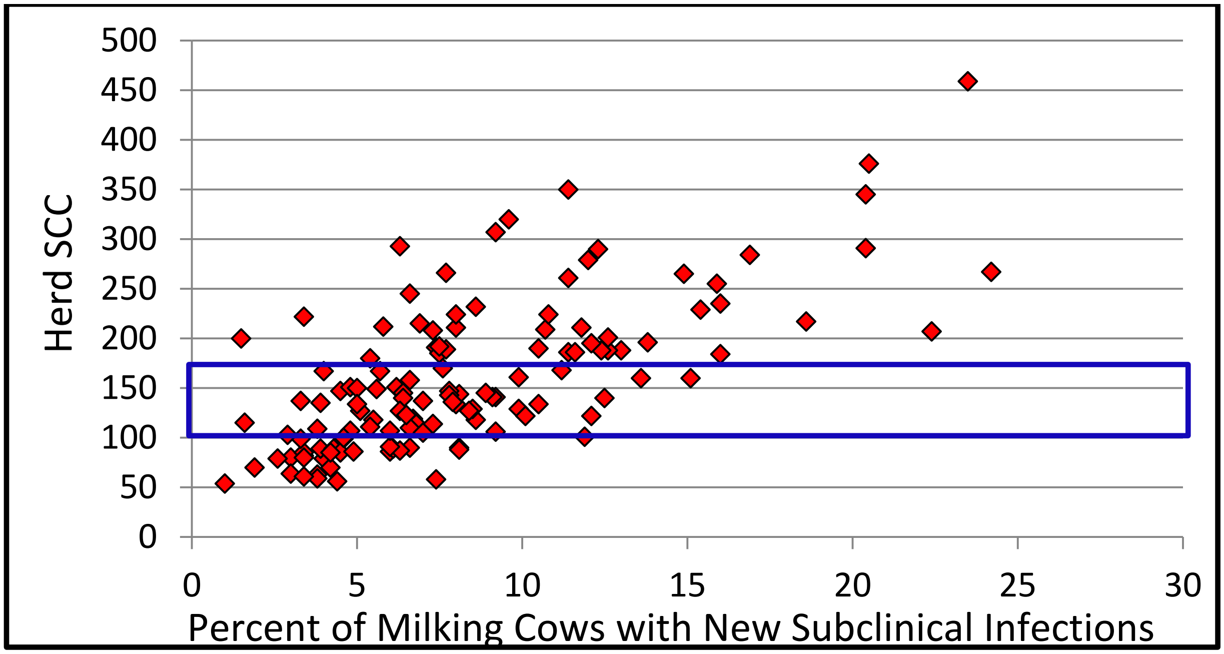

Figure 6: Scattergram of over 120 herds. The DHI herd average SCC is plotted against the new infection rate for each herd.

The answer is that the herds with the higher infection rates are maintaining lower SCC by culling cows, drying off quarters or treating clinical mastitis cases as they appear. These are all sound management options, but which herd, a herd with a new infection rate of 4% or a herd with a new infection rate of 15%, is spending more labour and money reacting to the problem, instead of preventing it? Which herd is likely using more antibiotics, losing potential genetic value in culled cows, and losing milk production in 3 quarter cows?

The greatest potential opportunity to use individual cow SCC is as a tool for fresh cow mastitis. Cows with chronic mastitis, measured by increased consecutive DHI test days with SCC ≥ 100,000 cells/mL, in early lactation have higher milk losses than cows with new infections later in lactation (Hadrich et al, 2018). Additionally, DHI records from > 166,000 cow-lactations in the western U.S. found that cows with a first test date SCC ≥ 200,000 cells/mL produced 718 kg less milk than cows with first test date SCC < 200,000 cells/mL, and were two to three times more likely to have clinical mastitis in early lactation and be culled by 60 days in milk (Kirkpatrick and Olson, 2015).

Herd average SCC are a great monitor for milk quality, but if maintaining a low SCC is done through reactive management strategies, rather than proactive strategies, the productivity of the herd is decreased despite having a desirable herd average SCC or bulk tank SCC. An ounce of prevention is worth a pound of cure.

Four useful measures of individual cow SCC to monitor the prevalence of subclinical mastitis are:

1. **Proportion of milking cows in a herd with subclinical mastitis:** The percent of milking cows with a linear SCC score (LSCC) of 4 or greater (or ≥ 200,000 cells/mL).

2. **The monthly new subclinical mastitis rate:** The proportion of cows that did not have subclinical mastitis on the last test date (LSCC < 4) but are now infected on the current test date.

3. **Dry cow subclinical mastitis rate:** The proportion of cows that did not have subclinical mastitis (LSCC ≥ 4) at the last test date of the previous lactation but have subclinical mastitis at the first test date of the current lactation.

4. **Proportion of fresh cows with subclinical mastitis:** The percent of cows that have a LSCC of > 4 on the first test date for the current lactation.

For examples of herd goals and articles about individual cow SCC, visit the following weblinks:

http://qualitymilkalliance.com/2015/01/17/is-cell-count-a-good-measure/

http://qualitymilkalliance.com/2013/07/01/herd-somatic-cell-counts-the-complete-story/

http://qualitymilkalliance.com/2018/07/25/revisited-article-you-are-here-on-the-somatic-cell-count-map/

▪ References

Erskine, R.J., B. Norby, L.M. Neuder, and R.S. Thomson. 2019. Decreased milk yield is associated with delayed milk ejection. J. Dairy Sci. 102:6477–6484.

Hadrich, J. C., C.A. Wolf, J. Lombard, and T.M. Dolak. 2018. Estimating milk yield and value losses from increased somatic cell count on US dairy farms. J. Dairy Sci. 101:3588–3596.

Kirkpatrick, M. A., and J. D. Olson. 2015. Somatic cell counts at first test: More than a number. Proc. of the 54th Ann Mtg Natl Mast Council, p. 53–56.

Penry, J. F., J. Upton, S. Leonardi, P.D. Thompson, and D.J. Reinemann. 2018. A method for assessing liner performance during the peak milk flow period. J. Dairy Sci. 101:1–12.