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LACTATION

TECHNOTE 12

Use individual cow SCC for management decisions

Individual cow somatic cell counts (ICSCCs) are the concentration of somatic cells (white blood cells and epithelial cells) present in milk from all four quarters of each cow and reported as cells/mL. On the day of herd testing, samples are taken from each cow throughout her milking using an approved meter.

With the exception of milk culture, ICSCCs are considered to be the best method of determining whether cows have subclinical mastitis (Holdaway *et al* 1996).

Cows regularly shed a small number of cells in their milk. In mid lactation, normal milk can contain 20,000 to 150,000 cells/mL. About 98% of these are white blood cells (e.g. 79% macrophages, 16% lymphocytes, and 3% neutrophils), and the remaining 2% are cells that line the ducts of the udder (Lee *et al* 1980).

Somatic cell response to mastitis infection

When bacteria invade the udder, passing the natural defence mechanism of the teat canal, the next line of defence relies on white blood cells. These cells are recruited from the circulation by chemical signals (chemotaxins) in response to this invasion. Once in the gland, the cells engulf and destroy bacteria using strong enzymes, and help to repair damaged tissue.

The number of cells in the milk of infected cows can increase from 100,000 to 100,000,000 cells/mL within a few hours in peracute clinical cases (Blowey and Edmondson 1995). There is a concurrent change in the types of cells present, with neutrophils contributing more than 90% of the cells in milk in cases of active infection.

In an individual cow the level and pattern of the cell count increase is affected by the number of quarters infected, and the type of bacteria causing the infection. Infections by *Escherichia coli* tend to be short-lived and cell counts rise sharply, then decline over 2-3 weeks. In contrast, *Staph. aureus* often persists as subclinical infections and cell counts from infected quarters rise and fall cyclically throughout lactation (Figures 1 and 2).

Confidence – High

Extensive research and field experience has shown that ICSCCs are a valuable tool to:

- monitor mastitis status at individual cow level,
- review mastitis management decisions, and
- solve problems in herds with high bulk milk SCC.

Research priority – High

Additional methods of dealing with high ICSCC cows (such as identifying cows that would be cost-effective to treat during lactation) would be useful.

The SmartSAMM Mastitis Focus report provides advisors and farmers with a tool to interpret, at herd level, ICSCC data and clinical records.

SmartSAMM recommends a minimum of bi-monthly herd testing, which generally equates to 4 tests per seasonal lactation.

The 'Detection of mastitis' Advisor Note describes cow-side methods for detecting subclinical mastitis.

Figure 1. Example of SCC response in a quarter with clinical mastitis due to Escherichia coli.

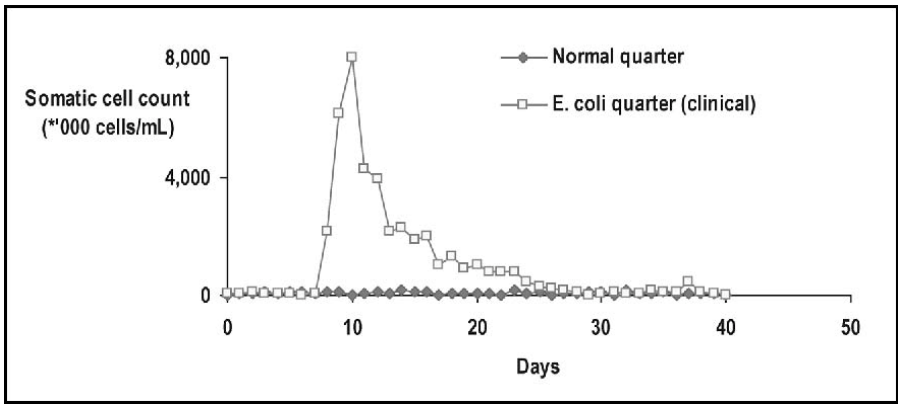
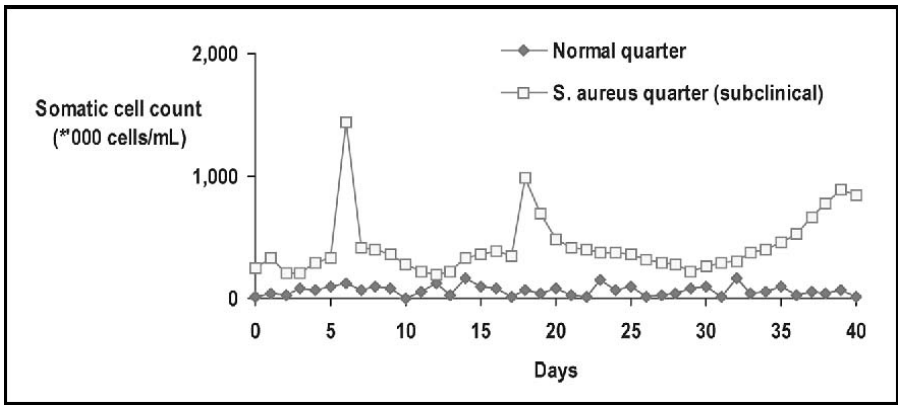


Figure 2. Example of SCC response in a quarter with subclinical mastitis due to Staph. aureus.



Analysis of ICSCC data reveals similar patterns. Infections by *E. coli* were associated with a rapid rise and decline in SCC between herd tests, while *Staph. aureus* was associated with more chronic elevations of SCC (de Hass *et al* 2004). Presence of streptococci was not associated with any clear patterns.

Examples of weekly changes in ICSCC for *Strep. uberis* and *Staph. aureus infected* cows are shown in Figures 3 and 4 (Williamson JH, unpublished results).

Figure 3. Example of cow SCC response for cows with different types of Strep. uberis infections, that were first detected at calving.

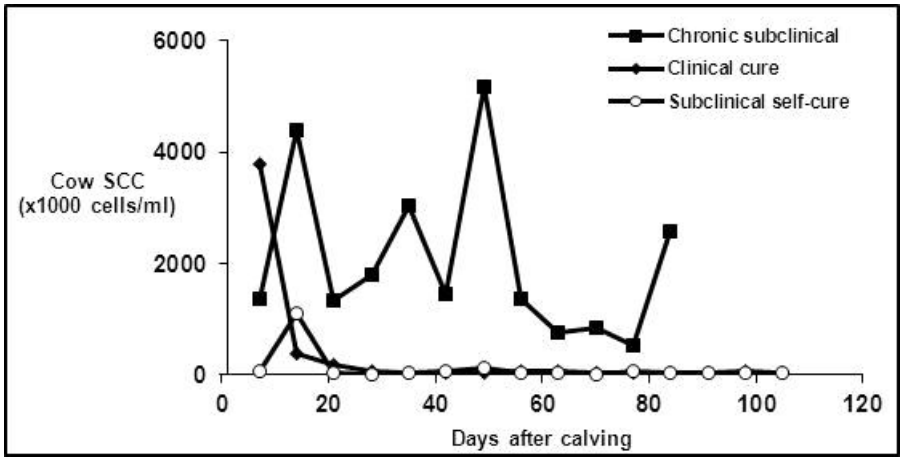
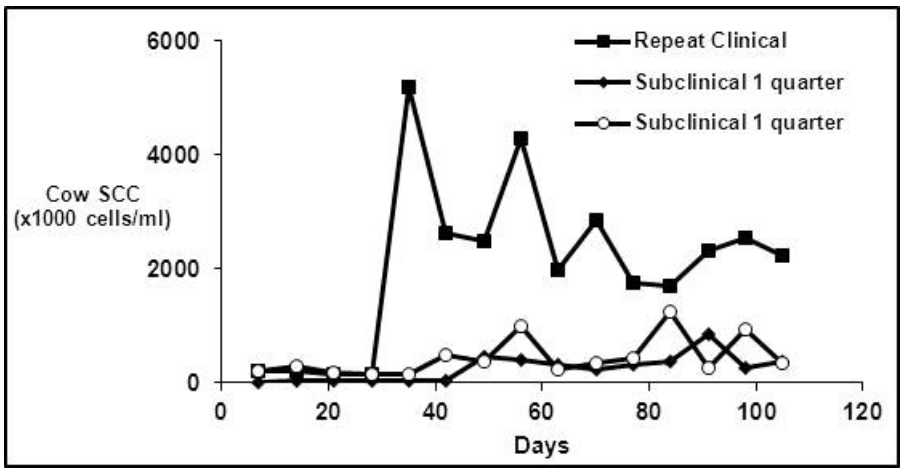


Figure 4. Example of cow SCC response for cows with Staph. aureus infections that were first detected in mid lactation.



Factors affecting somatic cell count

The major factor affecting milk cell count is intramammary infection (Harmon 1994, Schepers *et al* 1997). Although other factors are often suggested as causes of observed increases in cell count, few have a significant impact. The comprehensive review article by Harmon (1994) gives a good summary of the factors other than infection that may influence cell count, and clarifies some misconceptions regarding changes in cell count.

Calving

Regardless of mastitis status, cows may have elevated cell counts around calving. Increased milk cell counts are a normal immune response as mammary tissue changes in preparation for calving. Cell numbers decline quickly after calving in uninfected quarters. Sheldrake *et al* (1983) demonstrated that all quarters, regardless of infection status, had elevated cell counts immediately postpartum, but those quarters with no infections, or with minor pathogen infections showed a rapid decline in cell count.

Technote 3 discusses factors that affect bulk milk SCC and cow SCC after calving.

Cell counts in uninfected cows should be well below 300,000 cells/mL by five days post-partum. Although highly variable, the foremilk SCC of quarters infected with major pathogens remained high on the fourth day after calving compared to quarters free of infection or infected with minor pathogens (Figure 5, McDougall, S. unpublished).

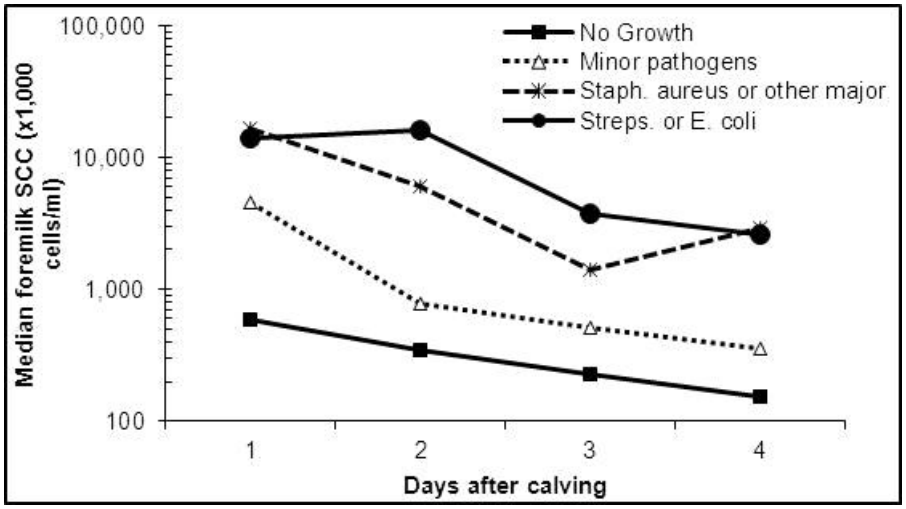
The 'Detection of mastitis' Advisor Note describes cow-side methods for detecting mastitis after calving.

Age and Stage of Lactation

Generally, cell count increases with advancing age and stage of lactation. However, Eberhart *et al* (1979) showed that if cows are separated into groups by infection status little change in cell count occurs for uninfected cows, either as they age or during late lactation. However, older cows are more likely to have a subclinical mastitis infection, and therefore a higher SCC, because they have experienced more days being milked.

Increased counts at the end of lactation, specifically in low producing cows, result from a constant number of cells being passed from udder tissue into a decreasing milk volume.

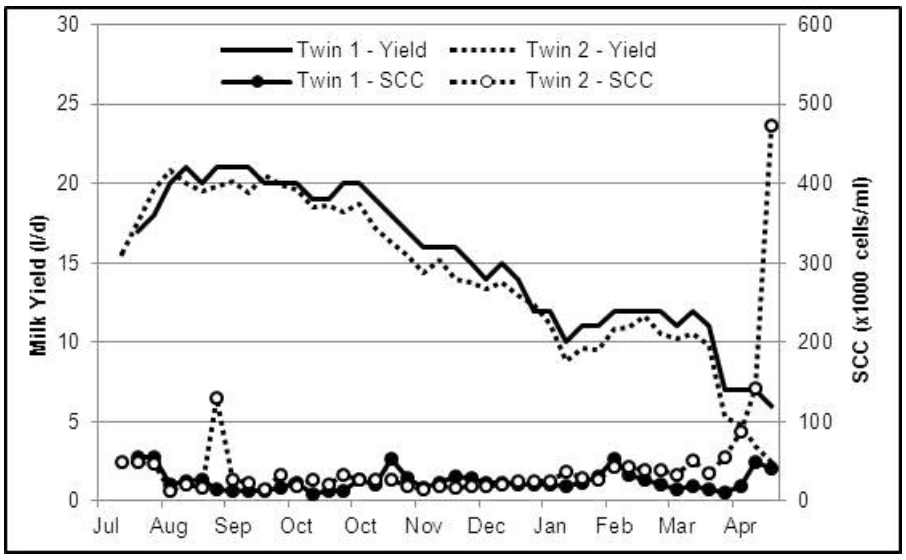
Figure 5. Median foremilk SCC for quarters sampled between 0 and 4 days after calving, categorised by pathogens present: No Growth, n = 5577 samples; Minor pathogens (i.e. CNS or Corynebacterium spp.), n = 235; Staph. aureus or other mixed major pathogens, n = 51; and Strep. uberis, Strep. dysgalactiae or E. coli, n = 158.



Cows at very low yields will start to show signs of accelerated involution, whereby the concentration of somatic cells being released into the milk increases, in the absence of infection. This is shown clearly by the changes in ICSCC for two members of an identical twinset (Figure 6), which remained uninfected up until dry off. One member produced more than 5 l/day (0.45 kg/d milksolids) until drying off and her ICSCC remained below 100,000 cells/mL whilst her twin's production dropped below 5 l/day and her ICSCC rose sharply in the last month of lactation.

Technote 16 discusses management of milk SCC before drying off.

Figure 6. Milk yield and ICSCC for an uninfected twinset where Twin 1 maintained production above 5 L milk/d and ICSCC remained below 100,000 cells/mL until drying off. Production by Twin 2 dropped below 5 L milk/d and SCC rose sharply before dry off.



Other factors

Although stresses of various types have been implicated as causing increases in cell counts, attempts to induce changes experimentally or by using corticosteroids have had modest or no effect (Harmon 1994). Similarly, there is no evidence that other 'stressors' such as stray voltage or oestrus significantly influence somatic cell counts. Withholding of milk caused by these activities are the more likely causes of elevated SCC for 1-2 days after these events.

Increased white blood cell counts arising from other diseases do not generally increase cell counts in the milk. During lactation, ICSCC vary within a day, both within and between milkings (usually low in the morning and higher at night). This normal variation during each day is the main influence on cell counts in cows that do not have mastitis.

Cows milked once a day throughout lactation have a higher SCC than those milked twice day. For example, Friesians milked once a day had a geometric mean SCC of 162,000 cells/ml compared with 74,000 cells/ml for those milk twice daily (Clark *et al* 2006). The transition from twice a day to once a day milking is usually accompanied by a rapid increase (or doubling) of ICSCC, and bulk milk SCC (BMSCC).

Benefits of using ICSCCs

ICSCCs collected regularly are used to identify cows with subclinical mastitis. This information enables farmers and their advisers to:

- estimate the prevalence of mastitis in herds;
- estimate the new infection rate or spread of infection in the herd;
- consider different approaches to Dry Cow Treatment – provided there are at least three ICSCC records for each cow during the current lactation;
- identify cows with persistent infections for culling;
- assess the contribution of individual cows if there are problems with high BMSCC;
- determine an appropriate milking order – where subclinical and clinical cases of mastitis are milked last;
- assess the mastitis status of purchased cows; and
- investigate outbreaks of mastitis in the herd.

Technote 14 discusses alternative Dry Cow Treatment strategies.

Technote 21 discusses purchasing cows.

Critical ICSCC thresholds

Individual cow SCC are composite milk samples collected from all four quarters. A count above 150,000 cells/mL in milk suggests that a cow is infected in at least one quarter. This threshold provides a reasonable division between cows with and without mastitis especially when applied in mid-lactation (Holdaway *et al* 1996), and has been used over the past 20 years.

A disadvantage of pooling milk samples from all quarters is that it dilutes high cell count milk with milk from uninfected quarters and increases the likelihood of missing an infected cow, however the ease and minimal cost of using herd test samples outweigh this disadvantage. Cell counts vary during milking, with foremilk and strippings higher than composite samples, so hand-collected samples taken from individual quarters cannot be compared with herd test samples.

A cow is classed as (likely) infected or uninfected according to her highest SCC result during the lactation. In New Zealand, where *Staph. aureus* and *Strep. uberis* are the main pathogens, cows are allocated an 'infected' status if their SCC ever exceeds 150,000 cells/mL, or 120,000 cells/mL for first lactation heifers. The Mastitis Focus report assumes that they remain infected until they have had 4 ICSCC results, or a dry period and 1 ICSCC result, below the threshold.

Herd improvement organisations can provide different somatic cell reports. One example is the LIC MINDApro Somatic Cell Count report, which provides the last 10 herd tests for individual cows (Figure 7). This data can be exported as a PDF, or to an MS Excel file for further manipulation. Web-based reporting systems are becoming available which allow data to be manipulated more easily.

Figure 7. Exert from a LIC MINDApro Somatic Cell Count Report. The "Current SCC Exceeded" column shows the number of ICSCC results above the relevant SCC threshold in the current lactation.

LIC

Somatic Cell Count Report

Sorted by Cow Number

Date: 13/03/2012

Animals Included: 598 **Group:** Whole Herd **Current as at:** 22/02/2012

Cow Number	Year Born	PW $	Previous SCC Exceeded	APR 2010 Count (000)	AUG 2010 Count (000)	OCT 2010 Count (000)	NOV 2010 Count (000)	DEC 2010 Count (000)	FEB 2011 Count (000)	APR 2011 Count (000)	SEP 2011 Count (000)	NOV 2011 Count (000)	FEB 2012 Count (000)	Current SCC Exceeded
1	2006	281/75	0/6	121	14	20	46	26	32	56	17	0	128	0/2
2	2009	173/42									27	7	32	0/3
3	2006	-130/77	0/6	167	16	39	22	15	29	129	25	22	218	1/3
4	2007	310/69	0/5	58	61	34	30	23		64	23	30	47	0/3
5	2000	81/84	0/6	204	17	23	45	39	30	97	27	13	24	0/3
6	2008	165/60	0/6		25	31	25	12	17	32	23	21	64	0/3

There is often a good deal of discussion about the most appropriate threshold to nominate for ICSCC. Like any diagnostic test, the ability of a SCC to predict whether a cow has mastitis depends on the accuracy of the test at a nominated threshold and the prevalence of mastitis in the herd.

At a threshold of 200,000 cells/mL, test sensitivity was estimated to be 89% and specificity to be 75 % for diagnosing prevalence of infections due to major pathogens (McDermott *et al* 1982), in 12 New York herds.

Using the 150,000 cells/mL threshold at any ICSCC in lactation, test sensitivity was estimated to be 92% and specificity to be 64% for diagnosing prevalence of major pathogen infections at the end of lactation across 6 NZ herds and 16,891 cows (Table 1; McDougall S, unpublished).

In summary, ICSCC can be used for a range of management decisions such as identifying infected cows for culling or for different Dry Cow Treatments. It is likely that use of different thresholds would be appropriate, depending on the economic consequences of the errors (i.e. missing infected cows or erroneously picking clean cows). However, in practice it is difficult to apply different thresholds to different herds, so the universal use of 150,000 cells/mL for cows and >120,000 cells/mL for heifers is a simplification that has worked well in NZ.

Table 1. Sensitivity (SE), specificity (SP), positive predictive value (PPV) and negative predictive value (NPV) of the maximum ICSCC (x1,000 cells/mL) during lactation for predicting if a cow has one or more quarters infected with a major pathogen or any pathogen at dry off. Data from 1681 cows from 6 herds with duplicate milk cultures after the last milking of lactation).

	Major pathogen				Any pathogen			
Cut-off	**SE**	**SP**	**PPV**	**NPV**	**SE**	**SP**	**PPV**	**NPV**
>150	0.92	0.64	0.23	0.98	0.55	0.77	0.79	0.52
>200	0.82	0.75	0.28	0.97	0.42	0.85	0.82	0.48
>250	0.76	0.81	0.32	0.97	0.34	0.88	0.82	0.46

12.1

Consult your advisor for advice on management of cows contributing high numbers of cells to the vat.

A BMSCC represents the total number of somatic cells in the vat divided by the total litres of milk. Although the BMSCC gives an overview of milk quality in the herd, cell counts from individual cows are generally required to diagnose and manage mastitis problems in herds.

The ICSCC (cells/mL) and litres of milk of each cow can be used to calculate the total number of cells each cow is estimated to be contributing to the bulk milk (litres x 1,000 x ICSCC). Milk volume and SCC data for individual cows can be exported from herd test organisations. For example, LIC MINDApro allows export of herd test data (or development of 'custom reports') from which production and SCC data can be obtained.

Data can be imported into Excel (or similar spreadsheet package) and the data easily manipulated. For example:

- Cows can be ranked in order of the number of cells they each contribute to the BMSCC.
- The effect on the estimated BMSCC can be calculated if a number of the higher cell count cows are left out of the vat.
- Once this information is available, a number of options can be explored to manage high BMSCC.

The main aim is to divert high somatic cell count from the vat through:

- Excluding cows from supply
- Strategic drying off of specific quarters or cows
- Strategic culling

Diverting milk from the vat

It can be profitable to divert milk from high cell count cows away from the vat. This requires that the payment for vat milk with a lower BMSCC exceeds the value of the volume of milk that is withheld. This must be determined by a calculation that can be easily set up on a spreadsheet (see Table 2). Diverting milk from high cell count cows away from the vat is a short-term strategy and not a long-term solution to mastitis problems.

It is possible to predict the BMSCC using the milk yield and ICSCC of individual cows. A BMSCC and average herd ICSCC taken on the same day do not always report the same value. Differences are usually explained by:

- Milk from some cows being withheld from the vat.
- Differences in sampling errors when comparing BMSCC measured on one vat sample compared to multiple tests collected across many cows.

Nevertheless, it is:

- an important option to be considered when a farm's BMSCC approaches or exceeds regulatory levels and the milk may be rejected; and
- a consideration for farms exploring ways to achieve and maintain premium payments.

Table 2. Calculation of the impact of excluding high SCC cows from the vat for milk payment whereby milk with BMSCC above 400,000 cells/mL attracts 1 demerit point or 5% of milk payment.

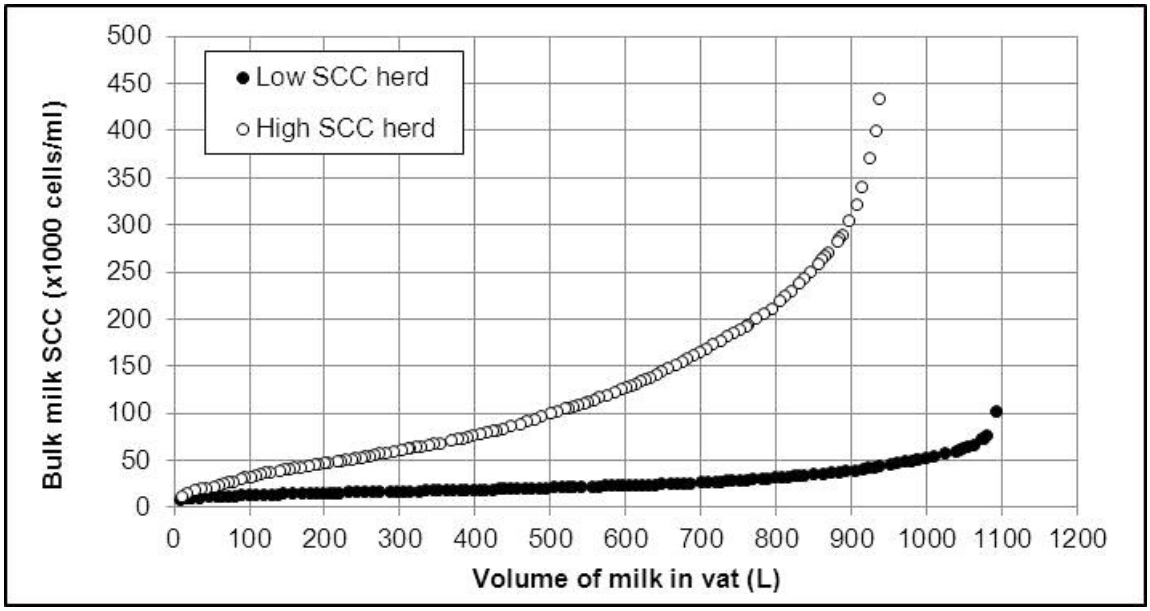
Step 1 Number of cells passed in milk by two high cell count cows			
	Volume (litres)	**Cow SCC (cells/mL)**	**Total cells from cow**
Cow 1	16 L	3,000,000 cells/mL	16 x 1,000 mL x 3,000,000 cells = 48,000 million cells
Cow 2	20 L	1,500,000 cells/mL	20 x 1,000 mL x 1,500,000 cells = 30,000 million cells
Step 2 Number of cells in bulk milk after excluding milk from these two high SCC cows			
	Volume (litres)	**Total cells in vat**	
Vat	Volume = 6,500 L SCC = 405,000 cells/mL Number of cows = 360	Volume x 1,000 mL x BMSCC = 6,500 x 1,000 x 405,000 cells = 2,632,500 million cells	
Vat excluding milk from cows 1 and 2	6,500 -20 -16 = 6,464 L	2,632,500 million - 48,000 million - 30,000 million = 2,554,500 million cells	
Step 3 Impact on final BMSCC and milk income by change in milk payment			
	BMSCC (cells/mL)	**Milk income ($)**	
Vat	405,000 cells/mL	6,500 L* 50 cents/L – 5% = $3250 -$162.50 = $3088	
Vat excluding milk from cows 1 and 2 =	Total cells ÷ total volume = 2,554,500 million ÷ 6,464 L = 395,000 cells/mL	6464 L * 50 cents/L = $3232 = gain of $144	

In this example, the economic benefit of diverting milk from 2 cows to move out of the penalty zone was worth $144 per day, and all but a small proportion of the economic penalty was recuperated. Diverting milk is usually judged worthwhile when grading for BMSCC.

If diverting milk to capture premium payments, it is wise to do a 'test run' that involves withholding milk from selected cows for two days and submitting milk to the factory for BMSCC testing. It is also important to determine that mastitis is not spreading through the herd because, in this scenario, it will be necessary to continue to divert milk from the vat to maintain BMSCC. The next decision is what to with these cows.

The incremental contribution of each cow to a vat for a high and low SCC herd is shown in Figure 8. As a general rule, removing up to 10% of the cows can reduce the BMSCC by up to 50% but will only drop the milk volume by 10%. This approach works well in mid lactation but may not hold true in late lactation, when there are many more cows with moderate to high ICSCC.

Figure 8. The contribution of individual cows, ranked from the lowest to the highest SCC cow, to the BMSCC and volume, is shown by the displacement of each dot along the x and y axis away from the preceding dot, of the next lowest SCC ranked cow.



Options for dealing with high cell count cows

There is no quick fix for treating high cell count cows (Shephard 1997). Control of this problem within a herd relies on preventing new infections in lactation, using an appropriate dry cow programme at drying off, using appropriate diagnostics to determine the underlying cause of the high cell counts and an effective culling program. This is frustrating for farmers and advisers, because milking high cell count cows reduces milk quality and potentially leads to mastitis spread.

There are a number of short-term management options that can be implemented when individual cows are identified as contributing high numbers of somatic cells to the vat. The final decision will depend on the number of cows with high ICSCC, whether mastitis is spreading through the herd, the production level and history of individual cows and time of the year/season.

Culling

Cows that have high cell counts across consecutive lactations, despite Dry Cow Treatment (DCT), should be considered for culling. Mastitis Focus criteria for culling are cows that still have ICSCC above 150,000 cells/mL despite the intervention of antibiotic DCT at the last 2 drying off periods.

Technote 15 describes issues to consider when culling cows.

Culling may be the best option for older cows that have chronic high cell counts where there is little prospect of improvement (for example those with *Staph. aureus* infection), particularly if small numbers of cows are involved.

Drying-off cows

Cows with high ICSCC (>150,000 cells/mL) cows can be dried off and treated with antibiotic DCT. Although they will not contribute milk for the remainder of the season, they may be cured and will be productive in future lactations. This may be the best option for heifers, and for cows nearing the end of their lactation that have had low cell counts in previous lactations.

Drying-off individual quarters

The Rapid Mastitis Test (RMT), or quarter sampling and culture can be used to determine whether infection is isolated to only one quarter.

Drying-off individual quarters may be the best option for cows with a single infected quarter that are likely to be culled at the end of their current lactation. Simply ceasing to milk the affected quarter results in drying-off for the current lactation. Permanent drying-off can be achieved by infusing iodine to destroy the milk-producing tissue (Middleton and Fox 2001).

Technote 4.13 describes how to permanently dry-off a quarter.

There are several disadvantages of drying-off only one quarter. The first is that there is always the possibility of accidentally milking the affected quarter into the vat! In addition there is less prospect of the quarter being cured prior to the next lactation as an individual quarter cannot be treated with antibiotic DCT during lactation, or infused with antibiotic DCT at the end of lactation when it is already involuted.

Whether or not this strategy impacts on the BMSCC depends on the number of cells that the affected quarter is contributing to the bulk milk.

Treating individual cows during lactation

Many studies have shown that it is not economic to routinely treat high SCC cows with antibiotics during lactation and the SmartSAMM Guidelines reflect these observations.

Case selection is important. Factors that impact on the probability of cure (Davis *et al* 1975; Sandholm *et al* 1990; Hillerton and Semmens 1999; Sol *et al* 1997; van den Bourne *et al* 2010a) include:

- Cow's age,
- Individual cow, and quarter, SCC
- Location of the quarter within the udder (front or back)
- Number of quarters affected within the cow
- Presence of any udder or teat end damage
- Pathogen type, strain and resistance to the antibiotic
- Duration or chronicity of the infection.

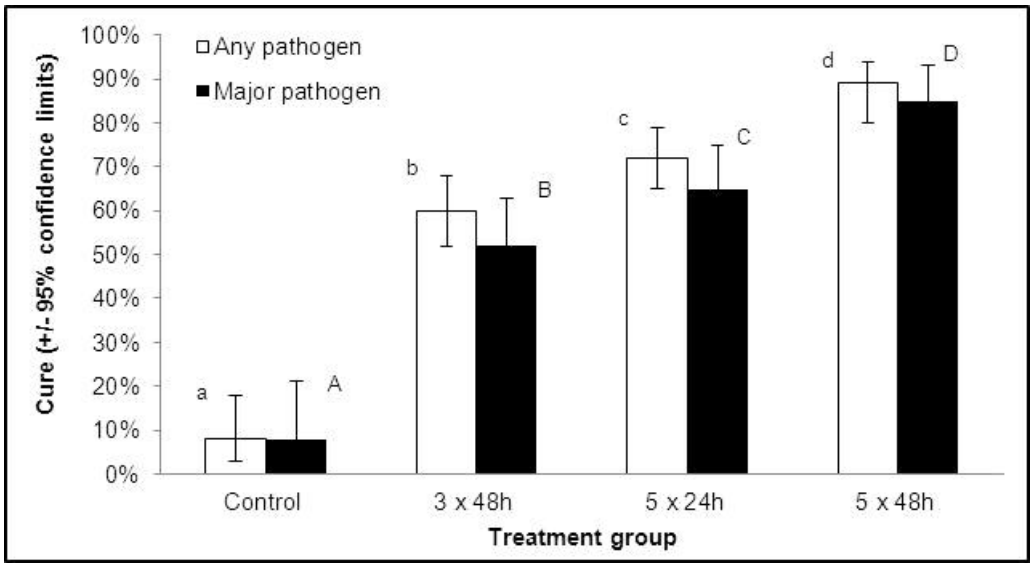
Where intramammary treatment is to be used, a process is required to select the infected quarters within the udder. A combination of elevated ICSCC (e.g. >500,000 cells/mL) and RMT may identify quarters with an elevated SCC, but some infected quarters may have low RMT score (e.g. *Staph. aureus* infected quarters).

Bacteriological cure rates may be increased by extending the duration of therapy. Internationally, Oliver *et al* (2004) demonstrated a 10%, 39%, 54% and 66% bacteriological cure rate, respectively of naturally acquired subclinical intramammary infection following Nil, 2, 5 or 8 daily

intramammary infusions with ceftiofur. Another study reported bacteriological cure rates of *Staph. aureus* of 6%, 56% and 86% following 0, 2 or 8 intramammary treatments with the lincosamide pirlimycin (Deluyker *et al* 2005).

In NZ, bacteriological cure rates of 13%, 24% and 53% of naturally acquired *Staph. aureus* infections were achieved following 0, 3 or 6 daily intramammary treatment with cefuroxime (Shelgren *et al* 2007). Increasing the duration and/or frequency of intramammary infusion with cloxacillin resulted in increasing bacteriological cure rates of naturally acquired infections with a variety of pathogens (Figure 9; McDougall and Compton, unpublished). Bacteriological cure rates of 16%, 32% and 56% of naturally acquired infections were achieved following 0, 3 or 6 daily parenteral treatment with penethamate (Steele *et al* 2010).

Figure 9. Proportion of quarters (mean +/- 95% confidence limits) with subclinical mastitis that cured for those left untreated (Control; n = 80 quarters) or for those treated with intramammary cloxacillin by one of three treatment strategies: 3 tubes at 48 h intervals (n = 281 quarters); 5 tubes at 24 h intervals (n = 279 quarters); or 5 tubes at 48 h intervals (n = 72 quarters). Infections were by any pathogen or by major pathogens: Staph. aureus, Strep. uberis, Strep. dysgalactiae, Strep. agalactiae, E. coli, Nocardia spp. Bars within pathogen group with different superscripts differ (p <0.05).



The costs of treating lactating cows are associated with purchasing antibiotic, withholding milk, and the diagnostic methods and errors of selecting cows for treatment (McDermott *et al* 1983).

The benefits may include the direct effects of reduced risk clinical mastitis, reduced SCC and reduced milk yield losses. There may also be indirect benefits associated with reduced cow to cow transmission and hence reduced costs associated with mastitis in the secondary cases (Swinkels *et al* 2005a).

Shephard *et al* 2000 reported no economic benefit in treating cows with SCC >500,000 cell/mL in the first month of lactation with intramammary (cloxacillin) and systemic (erythromycin) antibiotics compared with untreated cows, as there was no effect on bacteriological cure, SCC or probability of culling.

Similarly it was concluded that it was not economic to treat cows due to misclassification errors (i.e. uninfected cows being treated on the basis of elevated SCC) and as there was no effect on SCC (Douglas *et al* 1997).

More recently, economic analyses have suggested that it may be economic to treat cows in some circumstances. Treatment of subclinical mastitis cases due to *Staph. aureus* may be cost effective particularly where prolonged (8 day) therapy is used with a resultant high rate of bacteriological cure (Swinkels *et al* 2005a). Similarly where 3 days of treatment of *Streptococcus* spp. was found to be cost-effective (Swinkels *et al* 2005b).

However these models were sensitive to the rate of transmission of infection amongst cows, among other factors. Economics of treatment is cow-dependant with treatment of high value cows in early lactation more economic than treating lower value cows in later lactation (Steeneveld *et al* 2007).

More recently, modelling has suggested that optimal response to treatment of subclinical mastitis may occur in herds with low to moderate, rather than high, rates of cow-to-cow transmission (Barlow *et al* 2009). A similar conclusion was reached by van den Borne *et al* (2010b) who found the optimal economic return occurred where intervention occurred soon after new infection (associated with high cure rates and fewer secondary cases) and where cow-to-cow transmission was controlled by good management practices.

The economics of treating subclinical mastitis remains to be fully evaluated under NZ circumstances. There is little or no data on rate of cow-to-cow transmission, retention-pay off (cull), clinical mastitis rates where bacteriological cure fails etc. Given the paucity of data and the overseas analysis, the economics of treatment of subclinical cases remains unclear.

Treatment of subclinical cases as a primary method to reduce BMSCC is unlikely to successful, as the quarter-level and ICSCC remain elevated for some weeks post-treatment.

Using milk from high cell count cows to feed calves

The option of feeding high cell count milk to calves might offer a frustrated farmer some solace but should be carefully considered.

Transfer of *Strep. agalactiae* to group reared heifers has been documented (Johnson 1947). In an epidemiological study, 40% of 250 herd owners in a NZ study reported feeding mastitic milk to calves and this was associated (at univariate level) with increased incidence of clinical mastitis in the first lactation of heifers (Parker *et al* 2007). However, feeding of milk to which *Staph. aureus* had been added did not increase the risk of mastitis in exposed heifers (n = 29) compared to heifers (n = 35) fed control milk (Barto *et al* 1982).

Nevertheless, other concerns have been raised associated with feeding mastitic milk, including potential violative antibiotic residues in calf tissue (Musser *et al* 2001) or transfer or induction of antibiotic resistance in the intestinal flora of calves (Langford *et al* 2003). Additionally, transfer of other pathogens such as *Mycobacterium avium* subspecies *paratuberculosis* may occur (Ridge *et al* 2005). For these reasons feeding mastitic milk to calves is not recommended.

12.2

Consider milking chronically infected cows last to avoid contaminating other cows.

Segregation or separate milking of infected cows reduced the prevalence of *Staph. aureus* infection from 29.5% to 16.3% and the BMSCC from 600,000 to 345,000/ml over a 6 to 24 month period (Wilson *et al* 1995).

Technote 8.3 discusses milking order and reducing spread of mastitis.

12.3

Watch for evidence of spread of infection in the herd by checking the percentage of cows and heifers with increased cell counts each month.

ICSCCs can be used to monitor the status of herds with successful mastitis control and to investigate mastitis outbreaks (Ryan 1992). Analyses of ICSCC data can be used to:

- Monitor the spread of contagious mastitis, specifically when there is a high rate of new infections in heifers that were pathogen-free at calving;
- Examine the rate of spread of infection by determining the age groups of affected cows and the number of cows crossing the critical threshold (150,000 cells/mL) in a given time period;
- Identify cows to be sampled for milk culture; and
- Identify cows to be milked last or run as a separate milking herd.

Technote 5 describes management of *Staph. aureus* and *Strep. agalactiae* outbreaks.

Repeated ICSCC measures help to identify cows that do not have mastitis, and chronically infected cows with consistently high cell counts or cyclical peaks in cell counts. Changes in ICSCC status are also very informative as they suggest:

- New infections – in cows with ICSCC previously below the threshold.
- Cures during the dry period – in cows with previously high ICSCC that dropped below the threshold in their next lactation either as a result of treatment or self-cure.

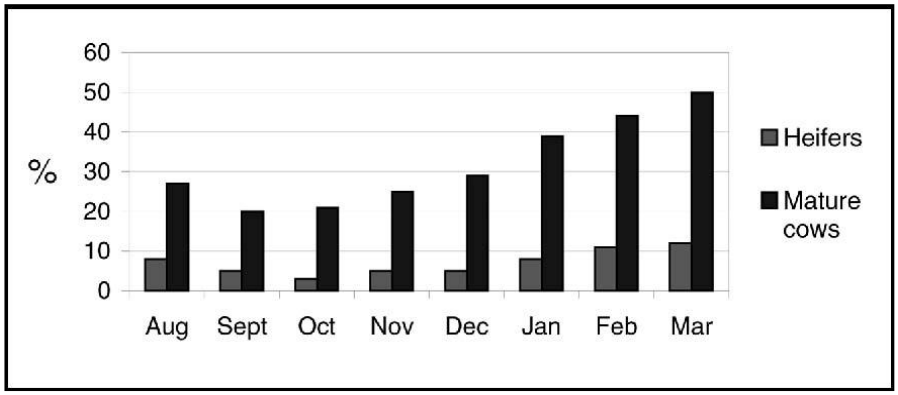
A high incidence of mastitis in heifers indicates the spread of new mastitis infections in the herd. Conversely, a high mastitis rate in older cows but not in heifers suggests that the infection is not spreading through the herd (Figure 10). As a guide, heifers are considered to have a high incidence of mastitis when more than 30% are above the 120,000 cells/mL threshold.

In cows with *Staph. aureus* infections, changes in mastitis status should be assessed between lactations because fluctuations in ICSCC are expected within a lactation.

Scattergraphs

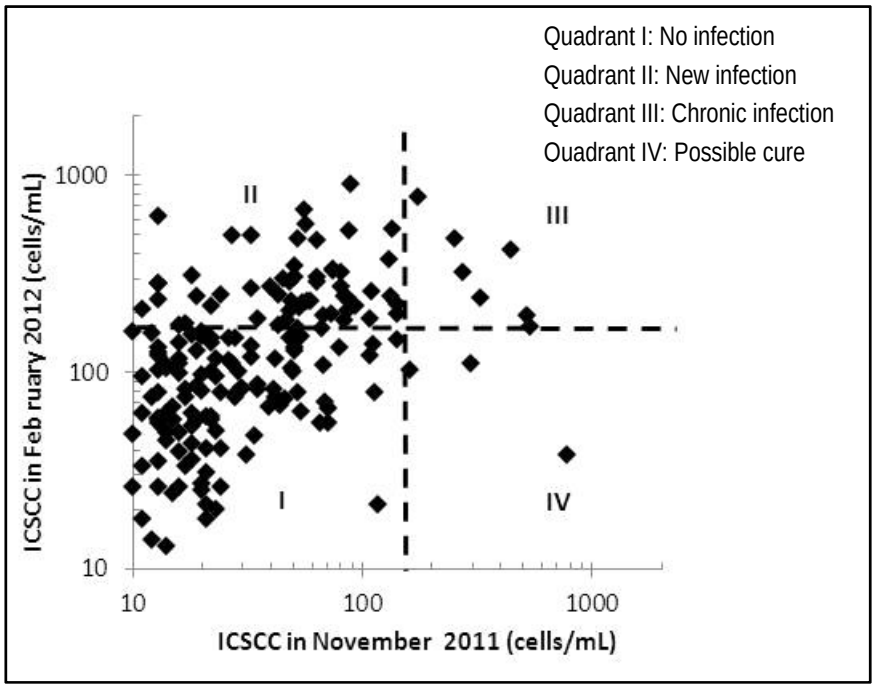
Changes in ICSCC status can be readily visualised in scatter graphs (Rapnicki 1997). Scattergraphs are plots of ICSCC taken in a previous period (x-axis) against current ICSCC (y-axis). By drawing a critical threshold (e.g. at 150,000 cells/mL) on each axis, the graph is divided into four quadrants (Figure 11).

Figure 10. A high mastitis rate in older cows but a low rate in heifers suggests the infection is not spreading.



The success of DCT strategies can be summarised by comparing the current and previous year's cell counts. Similarly, drawing graphs for cows of different parity or stage of lactation may assist investigations of mastitis problems in herds.

Figure 11. Example of a scattergram comparing the ICSCC at 2 sequential herd tests.



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