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DRYING OFF

TECHNOTE 14

Decide dry cow management strategy

At the end of lactation, dairy cows require a dry period that is sufficiently long to allow the udder tissue to repair and rejuvenate.

Alveolar cells, the cells that synthesise milk, collapse and the number of active alveolar cells declines to a minimum during the early dry period (Wilde *et al* 1997). New secretory tissue is laid down when cows start to 'freshen' ready for calving, so that the total amount of secretory tissue increases from one lactation to the next.

A minimum of six weeks (and preferably eight weeks) is recommended between dry off and calving for regeneration of udder tissue. A significant reduction in production has been observed when the dry period is less than 20 days (Kok *et al* 2017).

Closure of the teat canal with a keratin plug made from the cells lining the teat canal (Williamson *et al* 1995; Dingwell *et al* 2004) is another physiological change that happens at the start of the dry off period.This keratin plug helps to prevent new infections over the remainder of the dry period, but more than 20% of quarters may not have an effective teat end plug by five weeks after dry off (Williamson *et al* 1995).

Delayed closure of the teat canal after dry off has been associated with the presence of teat end cracks or lesions, the level of milk production before dry off (Dingwell *et al* 2004) or the milk flow rate before dry off (Summers *et al* 2004).

Accelerated closure has been associated with use of dry cow antibiotic treatment (DCT) at dry off, compared to no treatment (Williamson *et al* 1995). A physical barrier, formed by a non-antibiotic internal teat sealant (ITS), may also provide protection in the absence of a teat plug at the start and end of the dry period (Woolford *et al* 1998; Kabera *et al* 2018).

Antimicrobial resistance

Increasing antimicrobial resistance (AMR) is an issue for both human and animal health. The New Zealand dairy sector supports prudent and responsible use of antibiotics, to ensure their effectiveness in the future, and meet market expectations for animal care and welfare.

Antimicrobial stewardship is a key objective of the New Zealand AMR action plan. To action this, the New Zealand Veterinary Association (NZVA) supports a move towards more selective use of antibiotic DCT on dairy farms in New Zealand.

The type of dry cow used does not influence the development of antibiotic resistance. All active ingredients in antibiotic DCT available in NZ are ß-lactam antibiotics, which inhibit synthesis of the peptidoglycan layer forming the bacterial cell wall. Therefore, the use of any DCT (irrespective of the active ingredient and length of action) is likely to increase the risk of antibiotic resistance.

Evidence is emerging of the association between antimicrobial use on farm, and presence of antimicrobial-resistance bacteria:

- The proportion of NZ herds in which penicillin-resistant *Staphylococcus aureus* and *Streptococcus uberis* are isolated increases with increasing proportion of cows treated with antibiotic DCT (McDougall *et al*. 2022a).
- Organic herds have generally lower MIC for a range of antimicrobials than those herds that have used whole herd cloxacillin or cephalonium DCT for at least three years (McDougall et al., 2021a).
- The risk of penicillin-resistant *Staph. aureus* increases for herds with increasing use of penicillin-novobiocin DCT, and ampicillin-resistant *Escherichia coli* for herds following use of cloxacillin, penicillin-novobiocin, or cephapirin DCT (Saini et al., 2012, Saini et al., 2013).
- The risk of ampicillin-resistant *E. coli* increases following use of cefquinome or framycetin DCT (Schubert et al., 2021).
- Reduced sensitivity of faecal coliforms to cephalothin and streptomycin is reported for herds following cephalosporin DCT (Mollenkopf et al., 2010).

Therefore, the focus should be to target antibiotic DCT to cows that are likely to be infected.

14.1

Calculate dry off dates to ensure that all cows get at least a six-week (preferably eight-week) dry period.

Accurate expected calving dates are obtained through the combination of artificial breeding and/or natural submission information and early-aged pregnancy testing (cows tested at 5-16 weeks pregnant). These provide the best estimate of optimal drying-off dates.

The optimal dry period length is 6 to 8 weeks. This allows cure of existing intramammary infections and replacement of secretory cells within the mammary gland. Observational studies from North America (Kuhn et al 2006) and Europe (Kok *et al* 2017) have found that milk production is maximised with dry period lengths of approximately 40 to 60 days.

A systematic review by van Knegsel *et al* (2013) reported that shorter dry periods were associated with a 4.5% decline in milk production in the subsequent lactation, an improved postpartum negative energy balance and a better body condition score, but no effect on incidence of mastitis, metritis, retained placenta, or displaced abomasum, and variable effects on subsequent reproductive performance.

In herds that operate split calving, keeping track of individual cow dry periods can be difficult. Care should be taken to ensure that all cows experience a dry period of at least 6-8 weeks (42-56 days).

In New Zealand, most cows will have a dry period that is longer than 60 d. For cows treated with DCT alone, an increased risk of a new IMI with increasing length of dry period was reported in observational studies (McDougall 2010, Bryan *et al* 2011). Use of an internal teat sealant may provide extended protection in the dry period (Berry & Hillerton, 2007, Laven et al 2014) for cows that are likely to have an extended dry period.

Such cows can include young or low body condition cows that are being dried off early to maintain body condition, high SCC cows that are being dried off early to manage milk quality in the bulk tank, or mobs of cows that are being dried off early to manage feed supply in times of drought.

It is also important to know the length of the dry period to ensure selection of the most appropriate antibiotic DCT, to minimise the risk of antibiotics in the milk in the next lactation.

14.2

Dry off high SCC cows early to help lower bulk milk SCC.

SmartSAMM Technote 12 describes how to use individual cow SCC for management decisions.

14.3

Collect data to assess current situation and mastitis control strategies.

A milk quality consultation prior to drying off is an ideal opportunity to:

- assess the current milk quality performance of the farm, relative to the farmer's goals and national key performance indicators
- identify potential areas for improvement for mastitis control
- make herd and cow level decisions around culling and drying off treatment.

The information required to assess current management practices, prevalence and incidence of mastitis, and select cows for antibiotic DCT and internal teat sealants, may include:

- questionnaires and/or milking management visit reports
- bulk milk somatic cell count,
- individual cow somatic cell count (ICSCC) records, or RMT test scores,
- clinical mastitis treatment records and/or product sales,
- individual cow test results (e.g. microbiological, PCR) from clinical or subclinical mastitis cases.

Analysis of ICSCC, with or without the inclusion of clinical case information during the preceding lactation, has been shown to be effective across numerous national and international research studies to assess prevalence and incidence of mastitis and support selection of individual cows for selective antibiotic DCT.

Understanding of herd epidemiology is enhanced by collection of sufficient cow-composite or quarter samples for microbiology, and to focus mastitis control priorities on a farm.

When making decisions for individual cows, such as commencing antibiotic treatments, use of dry cow products or culling, use all relevant information for that cow, including age, clinical mastitis history, herd test SCC and other test results.

The results of tests for bacteria should not be used in isolation for drying off decisions, but if available, can be used alongside ICSCC results to make individual cow antibiotic DCT and ITS decisions.

When individual cow SCC (ICSCC) records are available, the DairyNZ Mastitis Focus Report or spreadsheets may be used to assess the prevalence and incidence of infection relative to industry best-practice trigger levels.

14.4

Plan to use appropriate treatment and prevention for all cows in the herd.

The SmartSAMM recommendation is to ensure that all cows are protected by some form of treatment during the dry period.

For most herds, selective antibiotic DCT is appropriate, which means identifying those cows that are eligible for antibiotic DCT. Best practice involves use of internal teat sealants (ITS) for all cows to reduce risk of new infections over the non-lactating period.

Use of selective antibiotic DCT at dry off has been comprehensively reviewed by McCubbin et al (2022). The selective approach involves:

1. **Use of antibiotic DCT to cure infections present at dry off**

   Antibiotic DCT is designed to ensure that antibiotic concentrations remain above the minimum inhibitory concentration of common mastitis bacteria for a determined number of weeks, maximising the chance of cure.

   Antimicrobial DCT results in a higher bacteriological cure rate than no treatment (Halasa *et al.* 2009; McMullen *et al.* 2021). Bacteriological cure rates are typically reported between 80 and 90% following use of antibiotic DCT under New Zealand conditions (McDougall 2010; Bryan *et al.* 2011), although quarters infected with *Staph. aureus* may have lower cure rates (~ 60 to 70%; (McDougall 2010).

2. **Use of ITS to prevent new infections during the dry period**

   Internal teat sealants (ITS) contain an inert material (usually bismuth subnitrate) that is intended to remain in the teat sinus and teat canal during the dry period to prevent new intramammary infections.

   For low-risk cows, use of this product alone reduces the prevalence of mastitis at calving, leading to a lower incidence of clinical mastitis and lower ICSCC in the next lactation (Woolford et al 1998; Berry and Hillerton 2002). The use of ITS alone reduced the risk of a new intramammary infection by 73%, relative to no treatment, and 25%, relative to antimicrobial treatment (Rabiee and Lean 2013).

   For cows eligible for antibiotic DCT, use of ITS in combination with antibiotic DCT can extend the period of protection afforded by antibiotic DCT alone. Use of a combination of DCT and ITS reduced the risk of new infection, relative to DCT alone, in cows with a high somatic cell count in the preceding lactation (Berry and Hillerton, 2007, Bradley et al 2010). It was also shown to reduce the clinical mastitis incidence rate and reduce the herd test SCC in the subsequent lactation (Runciman et al 2010, Bradley et al 2011).

   A New Zealand study confirmed that a combination of ITS with DCT in high SCC cows resulted in approximately 40% decline in risk of clinical mastitis, relative to DCT alone (Bates et al. 2016).

Selection of cows for antibiotic DCT

Antimicrobial therapy is appropriate for those cows with some evidence of mastitis. This could include:

1. ***Cows treated for clinical mastitis***

   Cows with a history of treatment for clinical mastitis in the lactation preceding dry off, and/or the last dry period should be considered for antibiotic DCT at dry off.

   This is because cows that develop clinical mastitis in one lactation are at 1.8x higher risk of intramammary infection at drying off and 1.7x risk of clinical mastitis in the first 60 days of the following lactation (Pinedo et al., 2012). Similarly, quarters which had a clinical mastitis in the preceding lactation were 4.2x more likely to have clinical mastitis in the first 120 days of the next lactation (Pantoja et al., 2009).

   Note that, in the absence of clinical records, most cows with clinical mastitis will have had a high ICSCC and thus be identified for DCT anyway. Conversely, addition of clinical records, over and above herd test records, does not improve accuracy of cow selection for selective antibiotic DCT (McDougall et al., 2021b).

2. ***Cows with 1 or more high ICSCC***

   Individual cow SCC provides a sound basis for antibiotic DCT decisions. An elevated ICSCC indicates presence of inflammation, due generally to the presence of a bacterial infection, and therefore eligible for antibiotic DCT.

   Common questions include:

   - ***Which herd test?***

   Individual cow SCC from 4 or more herd tests provides the best information for drying-off decisions.

   As a minimum, a single herd test SCC from the last 80 days prior to drying off, has been shown to be as predictive as having up to four herd tests across lactation, as a basis to define if a cow is infected with a major pathogen, or otherwise at drying off.

   In a study involving 36 herds across New Zealand (McDougall et al., 2021b), in which all four quarters from an average of 72 cows per herd were sampled at dry off, 8.6% of quarters cultured bacteria, but only 2.4% of quarters (7.2% of cows) were infected with a major pathogen (i.e. *Staph. aureus*, *Streptococcus* species or *E. coli*).

   - ***How many high tests?***

   Any cow with a high ICSCC at one or more herd tests in a lactation can be considered eligible for antibiotic DCT.

   - ***What threshold is appropriate?***

   When the threshold ICSCC is increased, the sensitivity (Se, i.e. the proportion of truly infected quarters detected) and specificity (Sp, i.e. the proportion of quarters defined as uninfected that truly were uninfected) alter for detecting quarters infected with a major pathogen (Table 1). The Se and Sp remain consistent amongst herds with

varying BMSCC and different prevalence of *Staph. aureus* (McDougall et al., 2021b).

In the past, thresholds of 150,000 cells/mL have been used. As herds implement better mastitis management in lactation, the threshold can be increased to 200,000 or 250,000 cells/mL.

Table 1. Classification of cows using various maximum cow somatic cell count (SCC x1,000 cells/mL) to define cows as likely to be infected with a major pathogen compared with actual, quarter-level culture results, where a cow was defined as infected with a major pathogen if one or more glands were culture-positive for a major pathogen. This table models a cow-level prevalence of a major pathogen infection in one or more glands at dry off, of 7.5% in a group of 500 cows.

Cut-point	Max SCC	N cows infected	N cows uninfected or minor pathogen	Se[1]	Sp[2]	PPV[3]	NPV[4]	N tubes DCT[5]
100	Above	34	186	0.91	0.60	0.15	0.99	**880**
	At or below	3	276					
150	Above	31	128	0.85	0.72	0.19	0.98	**636**
	At or below	6	333					
200	Above	29	**94**	0.78	0.79	0.23	0.98	**492**
	At or below	**8**	367					
250	Above	25	74	0.68	0.84	0.25	0.97	**396**
	At or below	12	388					

[1] Sensitivity

[2] Specificity

[3] Positive predictive value

[4] Negative predictive value

[5] Assuming that only cows with one or more SCC above the SCC cut-point would be treated with antibiotic DCT (1 tube/gland).

When using a maximum cow SCC of >200,000 cells/mL as the cut-point, for the last herd test within 80 days before drying off, the Se and Sp were 0.78 and 0.79, respectively (Table 1). Putting that in context, if a herd of 500 cows were to be dried off, and there was a 7.5% cow-level prevalence of major pathogens, then:

- 8 cows with a major pathogen infection would be false negatives, i.e. defined as uninfected due to a SCC ≤200,000 cells/mL, and
- 94 cows with no major pathogen infection would be false positive, i.e. defined as infected due to a SCC >200,000 cells/mL (Table 1).

So, assuming all cows with a maximum SCC above 200,000 cells/mL would be treated with antibiotics and those below the cut-point would be infused with a non-antibiotic alternative such as ITS, this would mean that 94 cows, free from a major pathogen infection, would be treated with antibiotics, and conversely, 8 cows, infected with a major pathogen, would be treated with ITS.

3. *Cows with a positive RMT result*

For herds that do not undertake herd testing, a rapid (Californian) mastitis test (RMT) provides an inexpensive indicator of SCC. It has the added benefit of flexibility with regard to time, in that it can be carried out close to dry off and requires no laboratory or third-party coordination.

Other alternatives to SCC testing, such as conductivity measured at a cow-composite level, or at quarter-level, are less predictive than RMT of SCC. Use of a combination of conductivity and RMT appears to add little value, above using RMT alone (Gohary and McDougall, 2018).

When an RMT cut-point of Trace or above for any quarter in a cow was used, the Se, Sp, PPV, and NPV were found to be 0.80, 0.50, 0.11, and 0.97, respectively (Gohary and McDougall, 2018). At quarter level, the Se, Sp, PPV, and NPV were found to be 0.93, 0.58, 0.05 and 0.99, respectively, for presence of a major pathogen when an RMT score or Trace or above was used as a cut-point (McDougall et al., 2022c). The use of ICSCC at a cut-point of >200,000 cells/mL had a lesser sensitivity but greater specificity. Thus, in the absence of any herd test data, RMT score, particularly at quarter level, provides a reasonable alternative to SCC.

Selection of cows for selective DCT using RMT at the quarter level resulted in reduced antimicrobial usage compared with whole herd DCT, but greater antimicrobial usage than cow selection based on ICSCC. RMT-based selection resulted in reduced incidence of new infection over the dry period, a lower prevalence of infection at calving, a tendency for a lower clinical mastitis incidence rate and a lower ICSCC at the first herd test compared with ICSCC-based selection (Swinkels et al., 2021, McDougall et al., 2022c).

Table 2. Number of cows or quarters classified as rapid mastitis test (RMT) positive (Trace or above) and the presence or absence of a major pathogen infection at the time of drying off. This table assumes a cow-level prevalence of a major pathogen infection in one or more glands at dry off, of 7.5% for 500 cows.

		Major pathogen infection		Total number of tubes of antibiotics used
		Yes	No	
Cow-level	RMT+	29	230	(29+230) x 4 = **1036**
	RMT-	7	233	
Quarter-level	RMT+	31	613	31 + 613 = **644**
	RMT-	13	1341	

Using the same 500 cow herd example as in Table 2, when the true cow-level prevalence of major pathogen infection was 7.5% (or 2.5% at quarter level), use of an RMT score of Trace or above, for one or more quarters within a cow, categorised 259 cows as infected. If all quarters of these cows were treated, a total of 1,036 tubes of DCT would be used (Table 2).

If decision-making occurred at the quarter-level, that is, only quarters with an RMT score of Trace or above were treated, then a total of 644 tubes of DCT would be used (Table 2).

Use of this approach could reduce antimicrobial use by 49% (cow-level) or by 68% (quarter-level), when compared with the 2,000 tubes required if whole herd DCT was used.

Decision-making may be influenced by other factors such as:

Confidence – Low

Selection for antibiotic DCT has traditionally been undertaken using SCC-based algorithms.

Culture-based selection have not demonstrated any additional benefits, over and above SCC-based algorithms (Rowe et al. 2020).

Research priority – High

Utility and economic benefits of culture-based selection approaches remains to be determined for herds in NZ pasture-based systems.

A. Other test results

On-farm tests are available to assist NZ dairy farmers to:

- Identify bacteria (if present) in clinical mastitis cases to define the aetiology and assist with case-specific treatments.
- Identify the bacteria in high ICSCC cows to assist with management decisions for these cows.
- Define the causes of clinical and subclinical mastitis and refine mastitis prevention and control strategies.

When using these tests the following should be considered:

a) Are the bacteria likely to be present at time of sampling? Some bacteria are shed intermittently so may not be detected by a single test
b) How has the sample been taken and handled before testing?
c) How accurate is the test for identifying the target pathogen?
d) What is the likely significance of the pathogen(s) that has been identified?
e) What other information e.g., cow SCC and clinical history, is available to support decisions?
f) How can the collective information be used to better focus prevention strategies?

Common isolates from clinical cases are likely to be *Staph. aureus*, *Strep. uberis* or *E. coli*, and all such infections warrant antibiotic DCT at dry off. Isolates from subclinical cases are more likely to be *Corynebacterium* spp., or Non-aureus Staphylococci (NAS), previously known as Coagulase Negative Staphylococci (CNS).

For more information on pathogens such as *Strep uberis* and *E. coli,* go to **SmartSAMM Technote 1**.

For more information on pathogens such as *Staph. aureus*, CNS and *Corynebacterium*, go to **SmartSAMM Technote 5**.

Utility of whole herd culture systems, over and above ICSCC, is currently uncertain. High ICSCC cows with a minor pathogen isolated, or low ICSCC cows with a major pathogen isolated, are examples of cows where the optimal treatment strategy is unclear. Currently, the best evidence across multiple studies supports selection of cows for antibiotic DCT on the basis of ICSCC, and results in effective management of mastitis.

The results of such tests should not be used in isolation for drying off decisions, but if available, can be used alongside ICSCC results to make individual cow antibiotic DCT and ITS decisions.

B. Cows with other risk factors

Cows producing >15 L of milk at the last herd test of lactation and over 4 years old are at an ~2-fold higher risk of clinical and subclinical mastitis over the dry period or subsequent lactation than younger and lower producing cows (McDougall and Castle, 2021, McDougall et al., 2022b).

Such cows may be considered for antimicrobial DCT, even where their maximum ICSCC may be below 200,000 cells/mL.

In addition, cows with teat end damage (e.g. very rough teat-ends) should also be considered for antibiotic DCT, since this may put them at higher risk of mastitis.

When might whole herd antibiotic DCT be considered?

SmartSAMM recommends that selective use of antibiotic DCT be considered as the default approach for most herds.

International experiences, as well as new evidence gained from NZ herds, is providing insights that only a small proportion of herds would genuinely benefit from whole herd DCT, compared to selective DCT (Table 3).

Table 3. Herds where whole herd antibiotic dry cow treatment (DCT) may be justified.

Measure of infection	Criteria
1. Bulk milk SCC	Arithmetic mean bulk milk SCC until end of 7th month of lactation ≥200,000 cells/mL (Equivalent to whole season bulk milk SCC above 250,000 cells/mL)
AND	
2. Indication of significant change in prevalence of infection during late lactation	Arithmetic mean monthly bulk milk SCC has increased by >40,000 cells/mL between the 6th and 7th month of lactation. (Equivalent to arithmetic mean monthly bulk milk SCC increases across last 3 months of lactation by ≥50,000 cells/mL).

Following the ban on whole herd antibiotic DCT in the Netherlands in 2012, implementation of nation-wide selective DCT was associated with no increase in new infection rate or decline in cure rate of over the dry period (Vanhoudt et al., 2018), reduced BMSCC, and no change in clinical mastitis incidence (Santman-Berends et al., 2021). This illustrates that effective mastitis control can occur with implementation of selective DCT alongside a comprehensive mastitis management plan. Steps to reduce spread of infection when cows are lactating are an important tool for reducing mastitis and managing milk quality.

In New Zealand, the impact of whole herd DCT approach, compared with a more selective DCT approach, on bulk milk SCC and clinical mastitis in the following lactation, is minimal. A currently unpublished retrospective study, involving ~1,100 herd-years has examined the association between proportion of cows in a herd receiving antimicrobial DCT at the end of a lactation and the bulk milk SCC and lactating cow treatment sales in the following lactation.

The strongest predictors of BMSCC and lactating cow antimicrobial drug sales were the previous lactation. Overall, use of whole herd DCT reduced lactational average BMSCC by ~16,000 cells/mL but there was an interaction of previous lactation average BMSCC, change in BMSCC over the last three months of lactation and DCT policy.

The only situations where a substantial benefit was associated with whole herd DCT, as indicated by an ~ 40,000 reduction in bulk milk SCC, was observed in herds where:

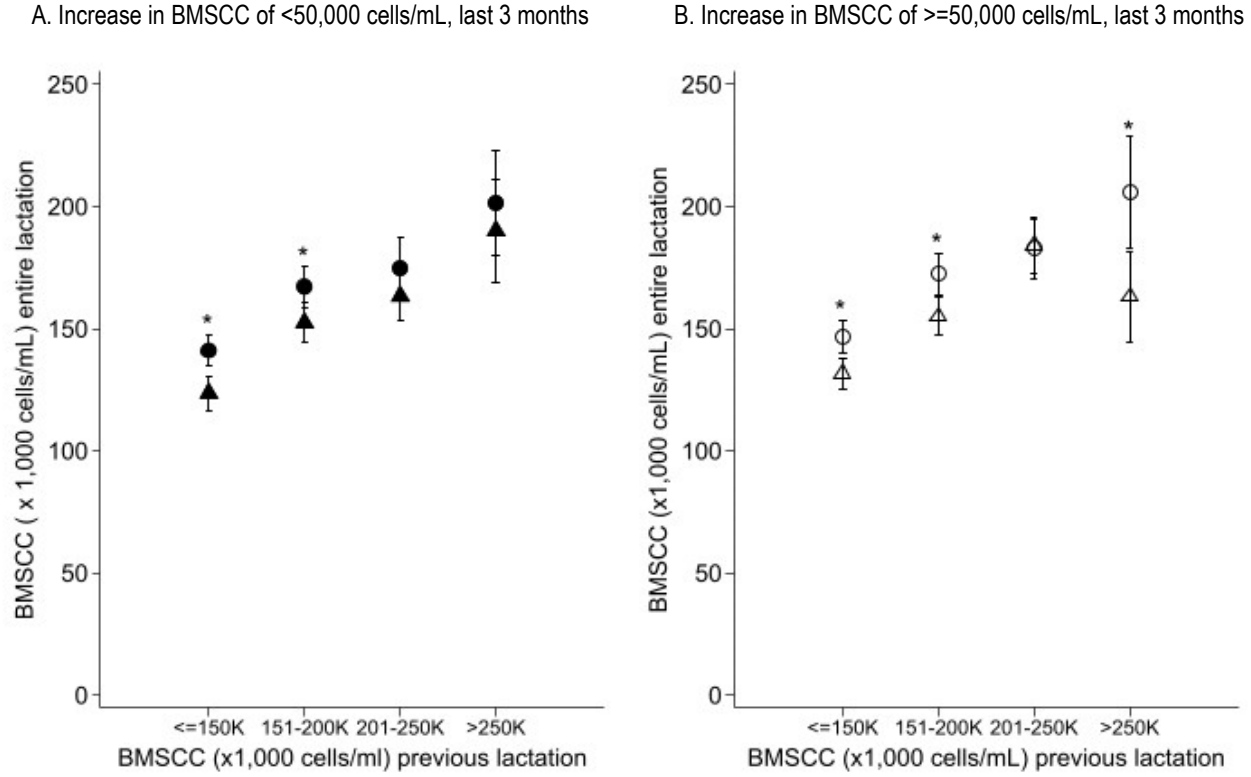
1. The bulk milk SCC averaged above 250,000 cells/mL over the entire preceding lactation, AND
2. The herd experienced a more than 50,000 cells/mL increase in average bulk milk SCC across between the 3rd last and last month of lactation in the preceding lactation (Figure 1).

The BMSCC amongst herds that had used selective DCT for multiple years did not differ from those that switched from whole herd to selective DCT at the last dry off. Thus, BMSCC can be managed for multiple lactations when using selective DCT.

Herds that used ITS across some, or all, cows at the end of lactation had BMSCC that were 10,000 and 7,300 cells/mL lower across the entire subsequent lactation, respectively, relative to herds not using ITS at all. Herds that used ITS in heifers had 8,000 cells/mL lower BMSCC than herds not using ITS in heifers. The effect of ITS was independent of whether the herds used whole herd or selective DCT.

Antimicrobial drug sales with indications for treatment of mastitis during lactation did not differ between herds that undertook selective or whole herd DCT. Additionally, there was no association between BMSCC in the preceding lactation, change in BMSCC over the last three months of lactation and antimicrobial sales in the subsequent lactation.

Figure 1. Average BMSCC (x 1,000 cells/mL) across the entire lactation (y axis) by the average BMSCC (x 1,000 cells/mL) in the previous lactation, stratified into 50,000 cells per/mL categories (x axis) and by change in BMSCC over the last 3 months of lactation, where panel A (closed symbols) is for herds where BMSCC changed by less than 50,000 cell/mL and panel B (open symbols) is where BMSCC changed by =≥ 50,000 cells /mL. Herds using whole herd antibiotic DCT are triangles (open or closed) while herds using selective antibiotic DCT are circles (open or closed). Asterisks indicate significant differences between selective and whole herd DCT within a preceding lactation BMSCC category.



Important reminders about use of different products

1) Selecting an appropriate dry cow strategy for a herd is just one part of a complete mastitis management plan.

Success of a dry cow strategy is as much dependent on the prevention and control measures operating during the lactation, as it is about the decisions and actions undertaken at dry off. Other mastitis control measures such as effective teat disinfection, machine maintenance, staff training and culling all play important roles in maintaining sustainable improvements in mastitis management and milk quality.

Confidence – Moderate

Because no antibiotic product is 100% effective, choices for a specific farm must be made on pathogens known to be present, and on the herd's previous response to antibiotic therapy.

2) The efficacy of ITS for protecting low ICSCC cows over the dry period has been demonstrated across numerous studies.

A meta-analysis found that ITS-alone was more effective than DCT-alone in reducing new intramammary infection rate over the dry period (Rabiee and Lean 2013) for low ICSCC cows. A more recent meta-analysis reported a 74% reduction in relative risk (RR) for new IMI at calving (RR =0.36, 95% CI: 0.25-0.72), and 57% reduction in risk of clinical mastitis in the first 30 days post-calving of lactation (RR =0.43, 95% CI: 0.17-1.10), for ITS treatment compared to non-treated controls (Winder et al., 2019), for cows with a low ICSCC. And no advantage was found for a combination of antimicrobial DCT and ITS over ITS alone, for low ICSCC cows (Winder et al., 2019).

Chronically infected cows are less likely to respond to DCT than more recently infected cows.

Where ICSCC are available, cows that a) had high SCCs in the previous lactation, b) were treated with an appropriate DCT at dry off and c) continue to have a high SCC the following lactation, could be considered as chronically infected and culled.

For low SCC cows, there was a clear benefit of ITS-alone, over no treatment, under New Zealand management systems, for reducing the incidence of new intramammary infection, and hence prevalence of infection at calving in both heifers and cows (Woolford *et al* 1998, Compton *et al* 2014), and for reducing incidence of clinical mastitis and high ICSCC in early lactation (Laven and Lawrence, 2008, Compton *et al* 2014, Bates and Saldias 2018).

3) The majority of infections present at drying off undergo spontaneous cure, when ITS is applied.

It was once assumed that no bacteriological cure would occur if ITS was infused in a gland with an existing infection at drying off (Berry et al. 2004). A retrospective analysis of three studies, involving 4,655 quarters from cows with a somatic cell count <200,000 cells/mL and infused with ITS-alone, found that 1.5% of the supposedly uninfected quarters that received ITS-alone were actually infected with a major pathogen (*Staph. aureus* or *Strep.* species) at dry off. Over the dry period, 3% of these infected quarters were diagnosed with clinical mastitis, but 92% of these major pathogen infections cured (McDougall and Compton 2015).

Similarly, a study in Southland found a 72% cure rate of existing infections following ITS alone infusion (Lacy Hulbert *et al* 2016). In that same study, 100% of low SCC cows treated with DCT cured. It should be noted in this study that the great majority of infections were associated with CNS and *Corynebacterium* species, with less than a quarter of the infections being associated with major pathogens.

Finally, in a study where quarters were allocated to DCT treatment based on a positive RMT test (i.e. Trace or greater), and quarters with a low RMT score received ITS alone, the bacteriological cure rate of existing infections

was 85% versus 95% for quarters treated with ITS-alone versus DCT and ITS (McDougall et al., 2022c).

Hence, although treatment of infected quarters with ITS-alone results in a lower bacteriological cure rate than when DCT, or DCT and ITS are infused, the difference in cure rate is less than 25%. Putting that in context, if all low SCC cows in a herd were treated with DCT, and only a small percentage were infected, the reduction in prevalence of IMI at calving in the herd would be very small, despite potentially a 2 to 3-fold increase in antibiotic use.

4) **When ITS-alone is prescribed, support for herd owners and staff is required to ensure hygienic application of product.**

The infusion process for ITS-alone may increase the risk of clinical mastitis in the early dry period. The most important factor associated with poor outcomes was found to be training of staff infusing the internal teat sealant (McDougall et al., 2019) and non-compliance with best practice at drying off (McDougall and Castle, 2021).

Such cases are associated with a range of bacteria, including Gram-negatives (e.g. *E. coli*, *Klebsiella* spp., *Proteus* spp.), *Staph. aureus*, and *Strep.* spp. The source of such infections may include existing infections, introduction of bacteria at the time of drying off (i.e. iatrogenic introduction), or post dry off infections. Factors such as pre-dry off milking frequency and nutrition, handling facilities, number of animals to be dried off, training and skill level (and patience) of the farm team, feeding and paddock selection before and after dry off, management of cows immediately post dry off (e.g. trucking, running to new pasture breaks) all need to be considered.

Formal training and monitoring of the infusion technique is highly recommended for farms when first using ITS-alone. One suggestion is to ask the farm team to collect milk samples after carrying out aseptic teat end preparation, and test for bacteria. Any contaminated samples should be regarded as evidence that ineffective teat preparation had been achieved, and that retraining is required.

It should be noted that, although fewer post-infusion problems appear to arise from DCT-infused animals, problems still do occur, due in part to the predominantly Gram-positive spectrum of DCT products. Hence, poor hygiene at infusion can result in introduction of Gram-negative bacteria, and infections, clinical mastitis and even death of the cow.

5) **Residues of teat sealants may be found in the colostrum and milk for a number of days after calving.**

Care should be taken to ensure cows are fully stripped out at each milking in the colostrum period to minimise the risk of ITS being present in bulk tank milk.

A Canadian study found that ITS was present at the first milking after calving in 83% of quarters. Interestingly, there was no effect of absence of ITS at first milking, and increased risk of new intramammary infection over the dry period (Kabera *et al* 2018). In a NZ study, ITS was visible in 67% and 72% of quarters at the first milking post-calving following treatment with two different internal teat sealants (Mehrtens et al., 2023). Another NZ study found a bimodal distribution in the mass of ITS recovered within 24-

hours of calving, but there was no association between mass recovered and probability of clinical mastitis in early lactation (Bates et al., 2022).

In a European study, the proportion of ITS recovered post-calving was also bimodal but the median was <50%, and was higher amongst cows treated with a combination of antimicrobial DCT and ITS (Swinkels et al., 2024). But again, no association was found between presence of ITS at calving and risk of subsequent clinical, or subclinical, mastitis (Swinkels et al. 2024). Internal teat sealants may persist in the mammary gland for possibly weeks post calving (Berry and Hillerton, 2002, Kabera et al., 2018, Swinkels et al., 2024).

In summary, when selecting an appropriate dry cow strategy for an individual herd, consider:

1. History of DCT and/or ITS usage over the past 12 months.
2. Incidence of clinical mastitis in previous dry period and at calving.
3. Incidence of clinical mastitis through the current lactation.
4. Average bulk milk SCC during the current lactation.
5. Individual cow SCC, including number and timing of tests.

When selecting the most appropriate antibiotic DCT product, the veterinarian should consider these factors, in consultation with the herd manager:

- Predicted length of the dry period and withholding period of the product.
- Likely pathogens, and their antibiotic sensitivity, that cause mastitis in the herd.
- Likely risk of new infections occurring in the dry period and at calving.
- Management of the risk of residue violations in meat and milk.

When ITS-alone is being considered, these factors should also be considered:

- Capability of farm team to infuse products using effective aseptic teat preparation techniques
- Opportunity to use trained technicians to support or undertake ITS infusions, where an appropriately trained farm team is not available.
- Ability of milking team to remove teat sealant after calving.

14.5

Consult with your veterinarian to select the most appropriate antibiotic DCT for your herd.

The SmartSAMM Mastitis Focus report will assist interpretation of ICSCC and clinical mastitis records.

Choosing the most appropriate antibiotic DCT for a herd depends on such factors as:

- spectrum of activity,
- likely cure rates,
- type of mastitis pathogen predominating in the herd,
- period of protection provided by different products,
- expected duration of the dry period for cows to be treated.

Confidence – High

Antibiotic DCT and ITS are effective tools for preventing new infections by *Strep. uberis* in the dry period.

Research priority – Medium

The biological and economic risk and benefits of a part herd antibiotic approach repeated year on year is unknown.

Cure rates following antibiotic DCT are influenced by the bacteria causing the mastitis and how long the cow has been infected, and these vary between herds. Generally, cure rates will be higher for *Strep. uberis*, *Strep. dysgalactiae* and *Strep. agalactiae*, and lower and more variable for *Staph. aureus*. Cure rates of 92% to 100% were reported following treatment of *Strep. agalactiae* infections with cloxacillin or cephalonium (Sol and Sampimon 1995). Cure rates for *Staph. aureus* ranged from 41% to 84% and tended to be lower in older cows (Ziv *et al* 1981).

Technote 1 summarises characteristics of *Strep. uberis*.

A meta-analysis found that the relative risk (RR) of bacteriological cure following antibiotic DCT, compared with no treatment, was 1.78 (95% CI 1.51-2.10) for all pathogens, 1.65 (95% CI 1.38-1.96) for *Staphylococcus* spp. and 1.86 (95% CI 1.48-2.35) for *Strep.* spp. (Halasa *et al* 2009). In the same study no difference was found between cloxacillin compared with non-cloxacillin dry cow antibiotics (RR = 1.00 (95% CI = 0.96-1.06).

Under New Zealand circumstances, cure rates of 79% for *Staph. aureu*s, 78% for *Strep. uberis* and 88% of minor pathogens were reported (Williamson *et al* 1995). In studies using cephalonium products (McDougall 2010; Bryan *et al* 2011), the cure rate for all pathogens was between 78% to 90% but cure rates were lower and varied across herds (60-75%) for *Staph. aureus* infections. Cure rates also varied with:

- Cow age, with cure rates of 95%, 90%, 91% and 85% observed for ≤4, 5, 6 and 7, and ≥8-year-olds, respectively.
- Increasing length of the dry period, with cure rates declining at 0.6%/week (McDougall *et al* 2010).

There are few reports on the cure rates for shorter versus longer acting products (Halasa 2009). Data are lacking to determine whether dry cow formulations with differing dry period withholding periods differ in bacteriological cure rate (McMullen et al., 2021). Bradley *et al* (2010) hypothesised that broad spectrum products, such as cefquinome (a 4th generation cephalosporin) may provide superior protection against new infections, compared with a narrow spectrum, cloxacillin product. But when used in combination with a teat sealant, the effect of a cloxacillin product was found to be similar to a broad-spectrum product (Newton *et al* 2008).

When tested in a later study (Bradley *et al* 2011), cure rates for major pathogen infections were found to be similar across treatment groups, but protection against new infections by *Strep. uberis* and other environmental bacteria was superior for groups treated with a broad-spectrum product, or

combination of cloxacillin DCT and ITS, compared with cows receiving cloxacillin DCT only.

The benefit of antimicrobial DCT to cure existing infections needs to be considered in light of the self-cure rate, since cure of infection does occur in quarters and cows not treated with antibiotics (i.e. left untreated or infused with an internal teat sealant).

Bacteriological cure rate over the dry period for antibiotic DCT compared with ITS was higher for *Strep.* species and "other gram-positive bacteria", but not for *Staph. aureus*, CNS or Gram-negative pathogens, in a retrospective German study (Müller et al., 2023).

Similarly, analysis of quarters known to be infected with a major pathogen, such as *Strep.* species or *Staph. aureus* at the end of lactation, and infused with an ITS alone had a bacteriological cure rate of 92% (McDougall and Compton, 2015). The bacteriological cure rate of major pathogen infections was 93% and 83% for RMT-positive quarters treated with antimicrobial DCT and ITS, compared to ITS-lone in cows with a maximum herd test SCC <200,000 cells/mL (McDougall et al., 2022c).

14.6

Purchase and store the antibiotic DCT and ITS you will need at dry off.

Hygienic preparation of the teat is critical before infusing intramamary treatments, especially ITS. See SmartSAMM Healthy Udder for a practical guide.

Farmers planning to administer DCT and ITS are advised to obtain their supplies (intramammary tubes, materials for teat sanitising etc.) well ahead of the dry off date. Advisers should emphasise the importance of correctly storing antibiotics, as specified on the label, for efficacy and safety reasons.

Technote 4.11 describes typical antibiotic residue violations associated with DCT products.

It is important to not store antibiotic DCT near tubes of Lactating Cow antibiotics. This reduces the risk of accidentally administering antibiotic DCT to lactating cows – which can be a very expensive mistake in terms of antibiotic violations and costs associated with withholding milk from the vat.

Use fresh supplies of teat wipes when administering dry cow products. Containers of wipes, once opened, dry out quickly over a few days and are then ineffective.

It is important that only new and previously unopened packages of teat wipes are used for sanitising teats prior to administering intramammary products, to ensure their efficacy. Teat wipes are only effective if they retain a high alcohol content, which can evaporate if wipes are stored incorrectly.

Note that a number of veterinary practices prefer to use cotton wool balls, soaked in 70% methanol or ethanol, as an alternative to teat wipes.

Under no circumstances should teat sealant or DCT tubes be made **wet or dirty** before use, as this greatly increases the risk of highly pathogenic bacteria being inserted into the udder.

Failure to properly sanitise the teat ends before intramammary infusions may result in severe or fatal cases of clinical mastitis, due to introduction of pathogenic bacteria from the teat end or from contaminated teat wipes.

Under cold conditions, warming of intramammary products prior to use may reduce their viscosity and improve their usability. This is best done by using a 'water-bath' technique, where the product is kept in its original plastic container and floated in a larger bucket filled with hot water for a period of time to warm the product through. **NEVER place the tubes directly in warm water.** An alternative approach is to place a hot water bottle in the midst of the tubes or store the tubes overnight in a hot water cupboard.

It is vital that individual treatment tubes are kept dry at all times and should never be placed directly in water. Failure to keep the tubes dry can lead to catastrophic outbreaks of clinical mastitis within a few days of treatment.

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