SmartSAMM Powered by DairyNZ

CALVING

TECHNOTE 4

Rapidly find, record and treat clinical cases in recently calved cows

Clinical cases of mastitis are costly and severely disrupt the flow of milking. Cases that are missed can markedly increase the Bulk Milk Somatic Cell Count (BMSCC) because they produce very high numbers of somatic cells in their milk.

The number of clinical cases detected within a herd is a function of the intensity of observation, and advisers therefore need to be aware of how different operators detect mastitis. People who forestrip are likely to identify many more cases than those relying solely on observing a swollen quarter.

Early detection and treatment of all quarters with clinical mastitis reduces the risk of severe and intractable cases developing, and reduces the likelihood of infection being passed to other cows.

The **SmartSAMM trigger for action of 10 cases per 100 cows (all ages) calved (15 cases per 100 heifers calved)** is based on farmer diagnosis of clinical mastitis within 14 days of calving. This may involve observations of any of the following: heat, swelling, pain, abnormal walking, poor milk-out, intense observation following discovery of clots on the milk filter, or frequent stripping of newly calved cows.

SmartSAMM considers a cow to have clinical mastitis and require treatment when there is an observable abnormality of the milk (i.e. wateriness, clots and/or discolouration) that persists for more than three squirts of milk. For cows with abnormalities in the first squirt of milk, followed by milk that is visibly normal, these should be marked and checked again for the next few milkings.

A case of clinical mastitis which requires treatment occurs when there is heat, swelling or pain in the udder, or there are changes in the milk (wateriness, clots, discolouration) that persist for more than three squirts of milk.

Research priority – Moderate

The relationship between single flecks or clots in the milk and the probability of intramammary infection and likelihood of subsequent CM diagnosis is not well understood.

SmartSAMM Mastitis Focus provides a comparison of a herd's clinical mastitis performance with triggers for action.

Technote 10 details how to rapidly detect and treat clinical cases in lactating cows.

The cost of a clinical case of mastitis

Many studies have been performed around the world to estimate the costs associated with mastitis. Factors that contribute to these costs include:

- antibiotics and other veterinary treatments,
- discarded antibiotic milk,
- production loss due to subclinical mastitis,
- production loss due to infected cows quarters or that have to be dried off early,
- penalties from exceeding regulatory BMSCC limits,
- labour costs for management of infected cows,
- costs associated with culling, unexpected deaths, and replacement of infected cows.

In 2006, a definitive New Zealand study was performed by the National Mastitis Advisory Committee to compare the costs of mastitis for an average herd, operating at an average incidence of clinical mastitis and BMSCC level, compared with the same herd performing at industry target levels.

The Cost of Mastitis report can be downloaded from the DairyNZ website.

The study used a milk price of $4.58/kg MS and based the estimate on a 315 cow herd, averaging at a BMSCC of 212,000 cells/ml, and performing according to the averages described in the herd improvement statistics for the 2005/2006 dairy season.

The study identified that a $6,000 saving could be expected by reducing the BMSCC to the industry target of 150,000 cells/ml, and that total costs associated with mastitis were in the order of $11,500 for the herd.

This original study did not account for several factors including:

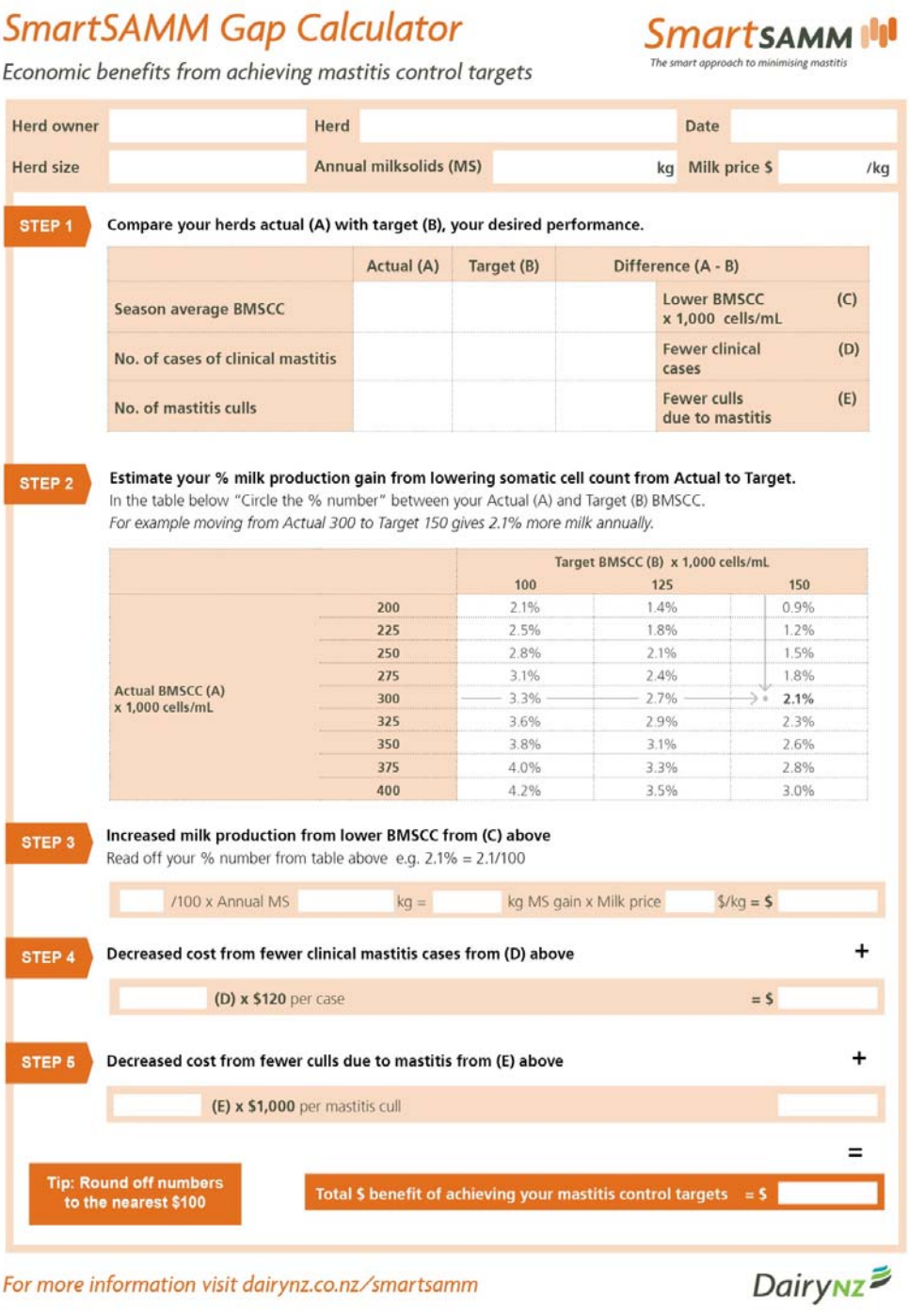
- the value of lost days in milk through early dry off of high SCC cows and/or early culling of infected animals,
- the extra seasonal production loss of 3.3% for cows that had been clinically infected,
- the increased risk of culling of infected animals for other parameters, principally reproductive failure.

It is not possible to make a general statement on the costs of mastitis for an individual farm because every situation is different. For this reason, the DairyNZ SmartSAMM Gap Calculator has been developed to allow calculation of the potential economic benefits associated with improving herd performance for BMSCC and clinical mastitis incidence for individual herds. The SmartSAMM Gap Calculator includes latest research results and rectifies the omissions of the earlier study.

The SmartSAMM Gap Calculator is available from the DairyNZ SmartSAMM website.

SmartSAMM Gap Calculator – Introductory version.

This version can be downloaded from the SmartSAMM website and completed using pen or pencil and desk-top calculator.



SmartSAMM Gap Calculator

Economic benefits from achieving mastitis control targets

SmartSAMM
The smart approach to minimising mastitis

Herd owner		Herd		Date	
Herd size		Annual milksolids (MS)	kg	Milk price $	/kg

STEP 1 **Compare your herds actual (A) with target (B), your desired performance.**

	Actual (A)	Target (B)	Difference (A - B)	
Season average BMSCC			Lower BMSCC x 1,000 cells/mL	(C)
No. of cases of clinical mastitis			Fewer clinical cases	(D)
No. of mastitis culls			Fewer culls due to mastitis	(E)

STEP 2 **Estimate your % milk production gain from lowering somatic cell count from Actual to Target.**
In the table below "Circle the % number" between your Actual (A) and Target (B) BMSCC.
For example moving from Actual 300 to Target 150 gives 2.1% more milk annually.

Actual BMSCC (A) x 1,000 cells/mL	Target BMSCC (B) x 1,000 cells/mL 100	125	150
200	2.1%	1.4%	0.9%
225	2.5%	1.8%	1.2%
250	2.8%	2.1%	1.5%
275	3.1%	2.4%	1.8%
300	3.3%	2.7%	**2.1%**
325	3.6%	2.9%	2.3%
350	3.8%	3.1%	2.6%
375	4.0%	3.3%	2.8%
400	4.2%	3.5%	3.0%

STEP 3 **Increased milk production from lower BMSCC from (C) above**
Read off your % number from table above e.g. 2.1% = 2.1/100

/100 x Annual MS kg = kg MS gain x Milk price $/kg = $

STEP 4 **Decreased cost from fewer clinical mastitis cases from (D) above** +

(D) x $120 per case = $

STEP 5 **Decreased cost from fewer culls due to mastitis from (E) above** +

(E) x $1,000 per mastitis cull

=

Tip: Round off numbers to the nearest $100

Total $ benefit of achieving your mastitis control targets = $

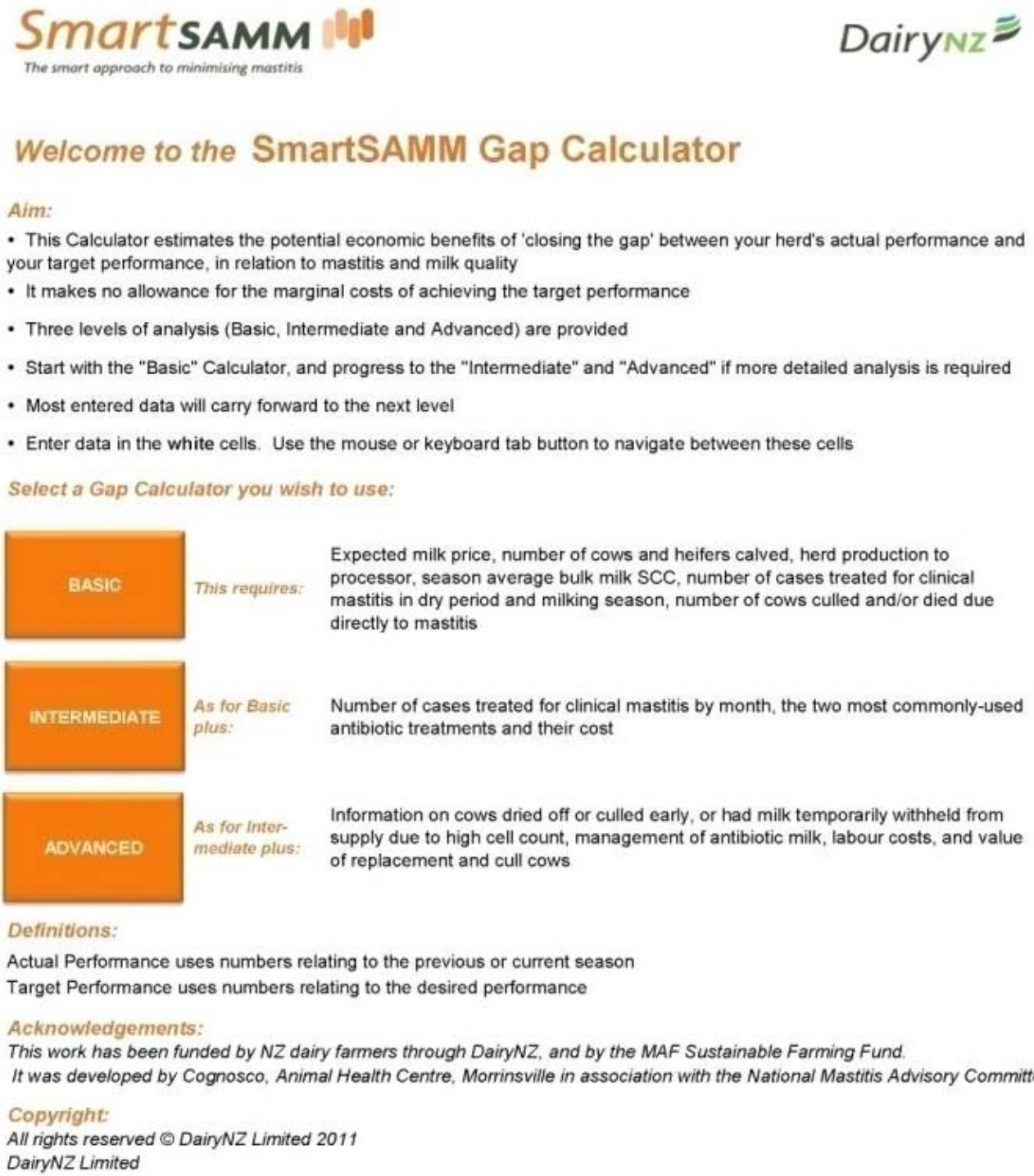
For more information visit dairynz.co.nz/smartsamm

DairyNZ

Advisors can generate printed copies of this Calculator and use with their clients.

SmartSAMM Gap Calculator – Electronic version.

This version can be can be downloaded from the SmartSAMM website, completed electronically and saved to your PC. Below is the Home page. Start with the Basic Calculator and progress through the Intermediate and Advanced Calculators if more detail is required.



SmartSAMM Gap Calculator – Basic.

Herd information is loaded into the white cells and the results reviewed by clicking on View Summary.

SmartSAMM
The smart approach to minimising mastitis

DairyNZ

Basic

< HOME | VIEW SUMMARY >

SmartSAMM Cost of Mastitis Gap Calculator

Advisor name	My advisor
Advisor's business name	My advisor's business
Herd owner	My herd owner
Herd name	My herd
Date of 'gap' calculations	Thursday, 18 August 2011
Expected milk price ($/kg MS)	$6.50

	Actual performance	Target performance	Industry top 10% performance	Gap between actual and target ($)
Total number cows & heifers calved	500	500		
Herd production to processor (kgMS)	175,000	175,000		

Mastitis control target components

1. Reduced bulk milk somatic cell count (BMSCC)				
Season average BMSCC (x 1,000 cells/mL)	300	150	125	
Total ($)	**$37,863**	**$13,975**		**$23,800**
2. Reduced clinical mastitis				
Number of cow cases of clinical mastitis in dry period	3	1		
Number of cow cases of clinical mastitis in milking season	72	38		
Overall clinical mastitis case rate (%)	15%	8%	8%	
Total ($)	**$8,706**	**$4,496**		**$4,200**
3. Reduced culling and death directly related to mastitis				
Number of cows culled due to mastitis-related reasons in season	10	5		
Number of cows died due to mastitis-related reasons in season	2	1		
Culling and death rate directly due to mastitis (%)	2%	1%	1-2%	
Total ($)	**$21,737**	**$10,869**		**$10,800**
Grand Total ($)	**$68,306**	**$29,340**		**$38,800**

4.1

Look for swollen quarters and check for heat and pain in all recently calved cows.

Confidence – High

Heat, pain, and swelling are classic signs of tissue inflammation.

The signs and techniques used to detect clinical mastitis are the same throughout lactation.

All cows should be visually inspected for swollen quarters at every milking. Cows that have swollen or painful quarters may appear lame – and this may be the first indication of a mastitis problem.

People who put cups on and take cups off should be inspecting every cow for swollen quarters at every milking. When viewed from behind, the two hindquarters should be examined for size and symmetry. In cows that have just calved, it can be difficult to pick swollen quarters and the best policy is to compare the suspect quarter with other quarters.

Recently calved cows with suspect quarters by gross observation should have their teats and udders palpated, and foremilk checked. Suspect udders should also be palpated when they are empty after milking.

The teat is palpated with the finger tips by gently rolling it between the thumb and first two fingers. Teat theilitis (inflammation of the internal tissues of the teat) is distinguished by hardening or thickening of the internal surface of the teat sinus.

The glandular tissue of the udder can be palpated superficially and deeply with the flat of the hand and fingers (Donovan *et al* 1992). Acute cases may be hot, swollen or painful but clinical mastitis cases with less obvious changes will require a more thorough examination, to assess the consistency of udder tissue. Chronic changes usually manifest as fibrosis, which can be felt as firmness that is local (from pea to fist size) or diffuse (giving the quarter a firmer feel than its opposite number and usually a more nodular surface). Long-standing infections can ultimately result in atrophy (shrinking) of the mammary tissue as it becomes non-functional.

4.2

Check milk from all quarters of recently calved cows before every milking while they are in the colostrum period (first 8 milkings).

Foremilk inspections are used to detect wateriness of the milk, a few clots or flecks, or more obvious abnormalities such as flakes, discolourations and blood. Milking staff may see 'strings' of material hanging from teat-ends. These are viscous debris (inflammatory products) that are expressed during milking and may, sometimes, be more obvious to the 'cups-off' operator.

It is recommended that each farm establishes a standard operating procedure to ensure that all cows are stripped every milking in the colostrum period.

As stated above, SmartSAMM considers a cow to have clinical mastitis and require treatment when there is an observable abnormality of the milk (i.e. wateriness, clots and/or discolouration) that persists for more than three squirts of milk. For cows with abnormalities in the first squirt of milk, followed by milk that is visibly normal, these should be marked and checked again for the next few milkings.

Before cows are moved out of the colostrum mob, every cow should be checked with a Rapid Mastitis Test (RMT) to check for subclinical mastitis. This test should only be used at the last 1-2 milkings in the colostrum period as falsely high results can occur, due to the presence of colostrum, in the first 24-48 h after calving.

Cows at high risk of mastitis should continue to be stripped regularly (at a minimum, weekly) as the lactation progresses. These include cows that have:

- not milked out;
- had a clinical episode of mastitis within the last month; or
- had high Individual Cow Somatic Cell Counts (ICSCC), recently.

Only cows that show visible clinical signs of mastitis should receive antibiotic therapy. All others should be monitored over the next few days for clinical signs of mastitis, unless recommended otherwise by the herd veterinarian.

Confidence – Moderate

Foremilk-stripping is the single most effective way to detect clinicals.

To improve sensitivity of detection, strip onto a black or dark surface e.g. strip cup, dark RMT paddle, black plastic.

Technote 5.2 describes routines for regular foremilk-stripping of the whole herd.

SmartSAMM Healthy Udder provides practical tips and step-by-step instructions for:

- foremilk stripping cows
- performing a Rapid Mastitis Test (RMT).

Technote 12.1 discusses options for dealing with cows with subclinical mastitis.

4.3

Collect milk samples for culture to identify the bacteria involved.

Confidence – High

Culture is the definitive method of identifying mastitis pathogens in herds – its cost is minor when compared to potential gains from incorporating the information into mastitis control programs.

Research priority – Moderate

Practicality of on-farm culture and molecular technologies e.g. PCR has yet to be determined for NZ.

The general principles for collecting milk samples for culture, as discussed below, are applicable to diagnosis of both clinical and subclinical mastitis, and also as part of investigation of problems in herds.

Milk cultures are recommended whenever a herd problem emerges, namely when there are more clinical cases than is acceptable or when the SCC is rising.

Virtually all mastitis is caused by bacterial infection. Milk cultures indicate the type of bacteria in the herd (e.g. *Staph. aureus*, *Strep. agalactiae* or *Strep. uberis)* so that appropriate management strategies can be developed. A number of milk samples are required to give a representative picture of what is happening in the herd (see 'Sampling strategy' below).

Cultures of milk samples from clinical cases

In practice, it is currently only possible to determine the bacteria causing mastitis by doing a milk culture.

It is not possible to determine the organisms responsible for a case of mastitis without culturing a clean milk sample. Cultures from cases of clinical mastitis can provide useful information on:

- Pathogen identification. This allows veterinarians and other advisers to use their knowledge of the epidemiology of the organisms to suggest possible sources of the infection and useful control measures for the herd.
- Antibiotic sensitivity testing of the isolated organisms. These tests are only considered as a rough guide to the likely treatment efficacy in live animals because bacterial kill rates on sterile plates in a laboratory do not necessarily translate to curative treatment in inflamed udder tissue.

It is a good insurance policy to collect samples from all quarters with clinical mastitis, and store them in the freezer. They won't necessarily all be submitted for culture but can be submitted to a laboratory if:

- a cow fails to respond to treatment;
- there is concern about the type of bacteria causing the mastitis; or
- there are a higher number of mastitis cases than expected ie:
    - More than 10 clinical cases in the past 100 calvings,
    - More than 15 clinical cases in the past 100 first-calver heifer calvings, or
    - More than one case per 100 cows per month in lactation.

SmartSAMM Mastitis Focus report provides a comparison of a herd's clinical mastitis performance with triggers for action.

Sampling strategy

SmartSAMM Healthy Udder provides step-by-step instructions for collecting samples suitable for bacterial culture.

An aseptic technique must be used to collect milk samples from the type of cases causing concern, prior to administration of any treatment. For example, if the concern is an outbreak of clinical mastitis in newly calved cows, the samples should be taken from these clinical cases. Bacteria isolated from high SCC cows in the herd at the same time may not necessarily be relevant to the clinical mastitis outbreak. Samples from cases that have recurred or failed to cure may also be unrepresentative of the overall problem.

The number of milk samples to be examined depends on the number of

cases of mastitis occurring and the reason for the sampling. For most herd problems, 20 samples (minimum of ten) are needed to get a reasonably reliable indication of the mastitis-causing organisms in the herd.

Between 10-40% of samples may return a result of 'no growth' (see 'Reasons for milk samples yielding no growth' below). If a herd problem appears to recur some time later (certainly if more than 12 months later), it is worth collecting another set of samples because herd profiles can and do change.

Recurring individual cases of clinical mastitis may have been 'superinfected' with other bacteria such as *Nocardia* or *Pseudomonas* introduced during the previous treatment infusion. This will only be detected if subsequent milk samples are cultured.

Sample collection

The main problems associated with milk culturing occur when samples are collected and transported. If correct procedures are not followed, milk samples can become contaminated with bacteria from water, mud or faeces, or from skin (milkers' hands or cows). These contaminating bacteria can multiply in the milk sample and confuse the test result. Aseptic sample collection and delivery of cool samples to a laboratory within 24 hours, or immediately freezing the samples after collection and then later submission, avoids these problems.

- On most farms it is the milking staff who collect milk samples from clinical cases.
- It is essential for advisers to ensure the milkers' sampling technique is satisfactory – a physical demonstration is often very helpful, supported by SmartSAMM Healthy Udder.

The SmartSAMM Healthy Udder resource provides a pictorial guide for teaching milking staff the aseptic technique required for collection of milk samples.

A milk sample is usually considered contaminated if three or more colony types are isolated from a quarter. The organism causing mastitis cannot be identified in contaminated samples. Contamination is often a result of poor sample collection technique, a dirty environment or dirty animals. Teat injuries, wet teats or udders, and hands contaminated with milk or water are other causes of contaminated milk samples.

Storage and handling of milk samples

Most bacteria that cause mastitis survive refrigeration for several days or freezing for several weeks. *Nocardia* species are an exception to this general rule, as storage of samples for only a few hours or freezing can reduce the likelihood of isolating these organisms.

The survival of *Staph. aureus*, *Strep. agalactiae, Strep. dysgalactiae* and *Strep. uberis* was not impaired in milk samples that were stored in a commercial freezer at -20^{o}C for 6 weeks (Murdough *et al.* 1996) or 16 weeks (Schukken *et al.* 1989). Other studies have found a variable effect on streptococci, especially *Strep. dysgalactiae* (Luedecke *et al.* 1972).

The survival of *Escherichia coli* and *Arcanobacterium pyogenes* can also decrease during freezing, with recovery rates for both pathogens decreasing by about 20% in samples frozen for four weeks (Schukken *et al.* 1989).

Freezing may increase the detection of coagulase negative staphylococci (Schukken *et al.* 1989) and possibly *Staph. aureus*, possibly due to the release of intracellular bacteria after the destruction of leucocytes during the freeze-thaw process. Samples found to have no bacterial growth when cultured fresh may become positive after freezing.

Inappropriate storage and handling on-farm will significantly reduce the chance of obtaining a meaningful culture result. It is not unusual to see samples sitting in the dairy for hours without refrigeration or on the dashboard of the car on Friday afternoon on the way to the veterinary clinic for submission to the laboratory. It is essential that the farm procedures for storing and handling samples are satisfactory. Chilly bins or similar items can be used to transport samples to the clinic and it should be emphasized that once a sample has been frozen and thawed once, it should not be frozen again.

Laboratory techniques

Techniques used in laboratories must be appropriate to achieve reliable isolation and identification of pathogens. This involves consideration of:

- Methods for sample preparation, including warming and mixing especially after freezing.
- Possible pre-incubation in growth media.
- Choice of culture media.
- Methods for inoculating plates to ensure suitable combinations of inoculum volume and surface area are used.

Different combinations may be optimal for different circumstances. Larger loop sizes, holding 25 µL or 50 µL of milk, are more appropriate for milk samples likely to contain less than 200 bacteria/mL, as the standard 10 µL loop is likely to result in growth of two or less colonies.

- Incubation temperature and times.
- Procedures for follow-up of samples with 'no growth', including tests for inhibitory substances, and examinations for other organisms.
- Procedures and tests for identifying pathogens from the primary culture.
- Procedures for antibiotic sensitivity testing.

At present in NZ, there are differences between laboratories in terms of techniques used for bacterial isolation, characterization, antibiotic resistance testing, and reporting criteria. Care should be taken in interpreting the laboratory results and second opinions sought from recognized mastitis experts if in any doubt about management and treatment recommendations.

The NMC (National Mastitis Council) in the United States released a revised edition of its 'Laboratory Handbook on Bovine Mastitis' in 1999. This handbook details microbiological diagnostic procedures that differentiate mastitis pathogens (National Mastitis Council 1999). Further information can be obtained from the website: www.nmconline.org.

Reasons for milk samples yielding 'no growth' after culture

Clinical cases of mastitis from which no growth is obtained are both common and frustrating. Many published surveys of clinical mastitis report 10-40% of samples with no pathogen isolated.

Possible reasons can include:

- Decline in the number of bacteria in the sample, by the time it reaches the laboratory, due to poor storage and handling.
- Elimination of the infection by host defence mechanisms by the time that the milk sample is collected. This is often suggested in the

case of coliform infections.

- Bacteria are present in too low a concentration to be detected by the laboratory culture technique used. For example, the inoculum size used on culture plates may be inadequate.
- Intermittent shedding into the milk of the infective organisms, such as *Staph. aureus*, which can reside deep within udder tissues, hidden inside abscesses.
- Antibiotic treatment of the quarter prior to sample collection, interfering with the ability to culture the infective organism. When submitting milk samples from cows that are not responding to treatment or are repeat cases, it should be noted on the laboratory submission form if they have received antibiotics within 14 days of sampling.
- Contamination of the sample with disinfectant at the time of collection interfering with the ability to culture the infective bacteria.
- The pathogen may not grow under normal culture conditions. For example, standard bacterial culture conditions are unsuitable for the detection of obligate anaerobes, mycoplasma and fungi.
- The clinical signs of mastitis are due to non-bacterial causes such as toxic substances.
- Isolated bacteria may not be reported because they are not considered to be major mastitis pathogens. For example, coagulase negative staphylococci are traditionally considered minor pathogens although they have been reported to cause clinical mastitis (Timms and Schultz 1987).

Antibiotic susceptibility testing

The disc-diffusion antibiotic sensitivity test (Kirby-Bauer method) is most commonly used in veterinary laboratories. The disc-diffusion method involves inoculating an agar plate with a standard inoculum, adding discs containing standardised quantities of antibiotics, incubating for 18 hours and measuring the zones of inhibition. In disc-diffusion tests, isolates are reported as susceptible, intermediate or resistant to the antibiotics that were tested. Many of the discs in use were designed in human laboratories and some drugs listed on the antibiotic sensitivity report may not be registered for use in cattle.

The fact that an antibiotic is found to inhibit growth in the laboratory does not necessarily mean that it will be successful in curing infections from the udder. However, antibiotic sensitivity testing does give an indication of which drugs are NOT likely to be effective (Ziv 1997).

Research priority – Moderate

Cut-points have only been established for a limited number of antibiotic and bacteria combinations for disc-diffusion test systems.

Antibiotic sensitivity tests show which drugs are not likely to be effective. Just because an antibiotic is effective at killing bacteria on agar plates in the laboratory does not mean it will have the same success in the cow.

4.4

Follow MRS T. Clearly mark cows to be treated.

Confidence – High

Clearly marking treated cows reduces the risk of antibiotic residue violations.

Marking cows for treatment is the first step in Mark, Record, Separate and Treat, otherwise known as MRS T. This system greatly reduces the risk of inhibitory substances reaching the vat milk.

MRS T means:

- **Mark** – her with the herd's recognized identification system for a new clinical case.
- **Record** – her details in the recognized farm dairy system.
- **Separate** – her from the milking herd, and milk her once the delivery pipe has been removed or shut off from the vat.
- **Treat** – her with the appropriate treatment, according to the farm's Animal Health Treatment Plan.

SmartSAMM Healthy Udder provides a useful reminder of MRS T for the whole milking team.

All milking staff should be familiar with the system used on each farm to identify cows that are to receive antibiotic treatment. Some methods for temporary cow identification are described in the Table below.

SmartSAMM Healthy Udder provides a reminder about MRS T and provides some examples of marking systems (see Figure below).

A separate identification system for marking cows that have received Dry Cow Treatment allows for easy recognition if cows re-join the herd in error, and can help relief milkers or casual staff avoid making costly mistakes.

Methods of temporary identification

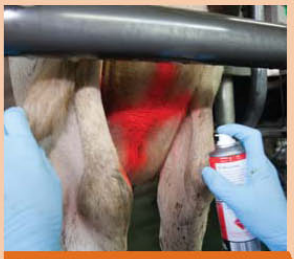
Method	Visibility	Durability	Ease of use
Velcro strips on legs	Excellent	Good	Easy to apply and remove
Insulation tape on legs or tail	Excellent	Good	Easy to apply and cut off NB. Tightly bound tape can cause impairment of blood circulation, resulting in tail amputation
Plastic hock strap	Excellent	Very good	Easy to apply and remove
Spray paint (non-scourable)	Variable	Good	Very simple
Spray paint (scourable)	Variable	Very poor	Not suitable
Tailpaint	Good	Excellent	Messy. Can paint over with new colour after treatment to avoid confusion
Paint stick/raddle	Good	Excellent	Simple; use like a crayon

Examples of temporary marking systems, from SmartSAMM Healthy Udder.

Treat 1

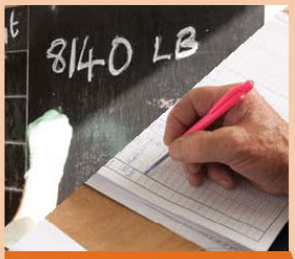
Mark
Record
Separate
Treat

Follow MRS T to avoid mistakes



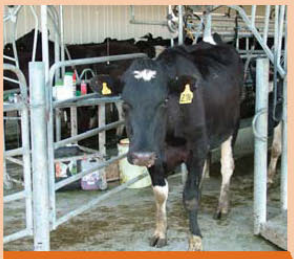
1. Mark

Mark first, when you have decided a cow needs antibiotic treatment.



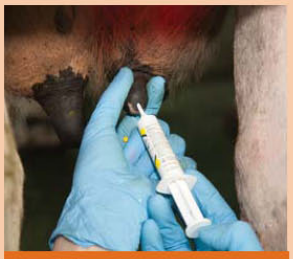
2. Record

Record her number and treatment details.All treatments must be recorded in your animal health records.



3. Separate

Separate her from the milking herd – to make sure you will not accidentally treat the wrong cow, or milk her into the vat once she is treated.

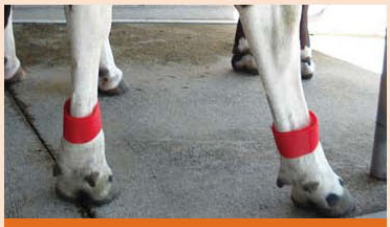


4. Treat

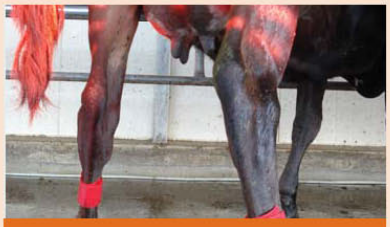
Treat her after marking, recording and separating. Refer to farm treatment plan for most suitable antibiotic product.

Examples of marking systems

Bright red paint



Leg bands



Use two systems

Mark treatments

Mark treatments (T1, T2, T3) with a line after each treatment.

Mark withholding

Mark with a line on each day milk is withheld after last treatment (D1, D2, D3, D4).

Mark clear to vat

Remember to **cancel paint** markings with a different colour.

Good marking and separation systems help prevent inhibitory substance grades.
Remember to explain your systems to your relief milker. Use signs as visual reminders.

Healthy Udder - 2011

DairyNZ

4.5

Follow MRS T. Record all details.

The New Zealand Food Safety Authority (NZFSA) Dairy Producing Code 2 (DPC2) describes the essential information to be recorded for each clinical case. Supplier contracts provided by milk processors detail their specific requirements for management and reporting of animal health treatments. Generally these include:

- identity of the cow (including affected gland(s),
- reason for treatment,
- treatment (drug),
- date treatment started,
- date treatment end,
- date milk returned to vat.

Advisers should assist farmers in developing a system, or Standard Operating Procedures (SOP), for detecting, identifying, recording, segregating and treating cows with clinical mastitis.

Permanent records of clinical cases need to be held for up to 4 years. This can be done using the LIC Yellow Book, the Fonterra Dairy Diary, Minda and MindaMobile, CRV Mistro, or other animal health management software packages.

Extract from the NZFSA Dairy Producing Code 2 (DPC2)

14 Animal Health and Treatment Records

(1) The farm dairy operator must keep records, using a unique animal identifier, which show:
- (a) the date that sick/diseased animals were identified and, where necessary, isolated from the herd;
- (b) the type of disease;
- (c) details of any treatment given to provide sufficient information for traceback purposes;
- (d) the date the milk was withheld;
- (e) the date the animal was returned to the milking herd; and
- (f) the name of the veterinarian consulted, if one was consulted.

(2) The records must be kept for 4 years, or longer if necessary, for traceback purposes.

Advisors should also encourage dairy farmers to keep permanent records of clinical mastitis cases so they can manage individual cows and assess herd-level mastitis control. With this information, they can:

- make decisions about how to dry-off cows (if Part Herd antibiotic Dry Cow Treatment (DCT) is being used);
- make decisions about which cows to cull;
- identify 'suspicious' cows (if clots are found on the filter or bulk milk cell counts rise);
- assess the number of mastitis cases and their response to treatment;
- calculate the cost of clinical mastitis in the herd;
- identify risk periods (e.g. stage of lactation) for clinical mastitis;
- determine the main mastitis pathogen(s) in the herd; and
- review effectiveness of mastitis control and udder health on the farm.

Herd improvement organisations provide services that can link clinical case information with details of a cow's age, production, ICSCC, previous

Transferring clinical records to herd improvement databases, or other management software packages, provides valuable storage and analysis functions.

Use SmartSAMM Mastitis Focus to analyse clinical records, in association with herd test data.

Use SmartSAMM Gap Calculator to determine the cost or value of improving udder health on farm.

clinical mastitis history, and previous treatment with antibiotic DCT and/or internal teat sealants.

4.6

Follow MRS T. Separate cows physically from the milking herd before commencing treatment.

It is recommended that cows be removed from the milking herd, as soon as clinical signs are detected, and before treatment commences. Milk from these cases should be withheld from the vat and discarded (see section 4.12 below) according to the farm protocol.

Gloves should be worn when handling milk from cows with clinical mastitis, and when administering treatments. Gloves are easier than bare hands, to rinse and sanitise after becoming contaminated with bacteria or antibiotics.

Technote 8.1 describes the benefits of hygienic milking practices, including wearing of gloves.

All treated cows should be run in a separate herd and in a secure paddock. These cows must only be brought to the farm dairy when all the milking cows have been milked and have left the dairy.

Technote 8.3 describes the advantages of segregating infected cows to reduce the spread of infection.

Prior to milking the treated cows, the operator must ensure that the milk delivery line is disconnected from the milk vat. If milk is harvested from cows under treatment or under a withholding period, and stored in a vat in the milk collection area, then this vat needs to be clearly labelled as not 'fit for supply' and the vat outlet must be locked to ensure that the milk cannot be collected by mistake.

4.7

Follow MRS T. Treat with the most appropriate antibiotic as advised by your veterinarian.

The goal of treatment is to cure the infection (bacteriological cure), return the affected mammary glands to normal milk production (clinical cure), and minimise pain and suffering of the cow. Ideally, the treatment period should be as short as possible and there must be no risk of antibiotic residues entering the milk vat.

Confidence – High

Antibiotics are legally restricted drugs that must be prescribed by a veterinarian.

Research priority – Low

Although comparative efficacy data for many product formulations is not readily available, there are appropriate antibiotics available for the common mastitis pathogens.

Staphs or Streps cause more than 80% of clinical mastitis cases in NZ. Antibiotics are the basis of most treatment regimens and are administered by infusion into the affected quarter (intramammary route) or by intravenous, intramuscular or subcutaneous injection (parenteral or systemic routes).

Other support therapies such as oral or intravenous fluids and anti-inflammatories may be used in very severe cases. Frequent stripping out and use of oxytocin to aid milk let-down are important adjuncts. Farmers should always be encouraged to remove milk from mastitic quarters, despite the fact that antibiotics have been administered.

Most cases of clinical mastitis are treated without the benefit of bacteriological examination of the milk before treatment is commenced. The treatment selected is based on the severity of the mastitis, the history of the farm (including previous milk culture results and responses to treatment), and the field experience of the farmer and the prescribing

veterinarian. In herds with clinical mastitis problems, milk samples should be submitted for culture to establish the farm profile of mastitis-causing organisms and develop appropriate treatment and control protocols.

Treatment should always be administered according to the directions given on the label and by the prescribing veterinarian. Recommended withholding periods must be observed for milk and meat.

Intramammary antibiotics

Intramammary treatment is practical and effective for cases where the inflammatory response does not block the teat canal or cistern.

Intramammary formulations should have the following qualities:

- The formulation should cause minimal irritation to the udder;
- The active ingredient must be effective against the pathogen;
- The active ingredient must distribute well through the mammary gland and persist in sufficient concentrations to achieve a cure in localised areas of infection;
- The antibiotic should exhibit a low degree of binding to milk and udder proteins; and
- The antibiotic should have a low degree of ionisation in the udder – in this form they are better retained in the udder.

Only use products registered for administration to food producing animals. Drugs such as phenylbutazone and gentamicin MUST NOT be used.
Additionally, intramammary use of products that are not meant to be administered into the mammary gland (I.e. Marbocyl) should not be practised.

In general, a smaller amount of active ingredient is required to achieve therapeutic concentrations when intramammary products are given compared to systemic doses. However, the inflammatory process in affected glands may impede distribution of antibiotics.

A conflict exists between the duration of treatment (in many cases, longer treatment is associated with improved cure rates) and the desire to minimise the period over which milk must be withheld from the vat. All treatments have specified minimum treatment courses that should be adhered to.

Dry Cow Treatment preparations of antibiotics should never be used in lactating cows. Inadvertent use of antibiotic DCT requires milk to be discarded for extended periods of time.

Systemic antibiotics

Acute, or severe, mastitis cases may benefit from both intramammary and systemic antibiotics. Peracute cases often require systemic antibiotics and anti-inflammatory preparations, and possibly intravenous fluids. The prognosis for peracute cases in cows with severe clinical signs (as indicated by body temperature, dehydration, etc.) is poor, regardless of treatment.

Systemic therapy may be useful (and economic) where more than 1 quarter is involved, where teat end damage is such that intramammary infusion is difficult and in heifers with udder oedema.

Systemic antibiotics have the advantage that drug distribution is not impeded by local inflammatory reactions in the udder. However, to be effective, systemic antibiotic treatments must be absorbed from the injection site and pass from the blood into the udder. Their major difficulty is penetration of the “blood-milk barrier”.

Drugs move across the blood-milk barrier by passive diffusion of the non-ionised parts of the molecule according to the principle of osmosis. This

barrier is penetrated by the non-ionized, lipid soluble, non-protein-bound drug fractions.

Weak acids (e.g. penicillin G) are almost completely ionised in blood and have poor tissue penetration. On the other hand, penethamate hydroiodide achieves concentrations in the milk that are 5-10 times higher than other penicillin salts due to its basic and lipophilic properties. This treatment results in high levels of penicillin in the udder because it is hydrolysed as it crosses into milk, liberating active benzyl penicillin.

Some macrolides (e.g. tylosin) also are lipophilic and concentrate in the udder after systemic treatment. For this reason they have been used for clinical mastitis therapy (McDougall *et al* 2007a). Allowing for antibiotic sensitivity patterns, antibiotics with high milk-to-plasma ratios are most suitable for systemic administration (see Table in margin).

Milk-to-plasma ratios of some antibiotics used to treat mastitis (Anderson 1989).

Antibiotic	Milk-to-plasma ratio
Trimethoprim	3.7
Lincomycin or Erythromycin	3.0
Tylosin	2.0
Tetracycline	0.7
Streptomycin	0.5
Ampicillin	0.25
Sulphadiazine	0.21
Penicillin G	0.15

Clinical reports and studies suggest “that the combined systemic and intramammary antibiotic treatment may result in a slightly but significantly higher rate of bacteriological cure in the treatment of acute staphylococcal and streptococcal mastitis” (Ziv 1997). But systemic treatments use much greater volumes of antibiotic compared to intramammary treatments

Extended therapy with an intramammary product achieved an effective cure of acute streptococcal mastitis, for the minimum amount of product used (Hillerton and Kliem 2002), but substantive field data to support extended approaches are currently unavailable.

Published cure rates of antibiotics

In a review of antibiotic treatment of clinical mastitis during lactation, Craven (1987) reported average cure rates for each antibiotic from scientific papers that stated the number of quarters treated and had rigorous bacteriological assessment. From these data (see Table below), it was not possible to draw firm conclusions about the relative effectiveness of different products given the wide range of cure rates for similar antibiotics. There was a consistently greater bacteriological cure rate for treating *Strep. agalactiae* infections than those due to *Staph. aureus,* although cure rates were low for both organisms treated with neomycin.

Efficacy of treatment with different antibiotics (Craven 1987)

Antibiotic	**Cure of *Staph. aureus***			**Cure of *Strep. agalactiae***		
	Mean (%)	Range (%)	Reports (no.)	Mean (%)	Range (%)	Reports (no.)
Penicillin	32	0 – 87	12	84	50 – 100	11
Cloxacillin	41	21 – 84	14	92	40 – 100	8
Neomycin	27	25 – 36	2	27	27	1
Tetracycline	54	17 – 96	8			
Erythromycin	63	51 – 76	2			
Pen / Strep	39	21 – 78	5	91	91	1

Clinical cure rates (i.e. resolution of clinical signs) of clinical mastitis cases generally occur in 80-90% of cases. Where more than 20% of cases recur (i.e. are retreated within 4 weeks if initial treatment) an investigation should be undertaken.

Bacteriological cure rates (i.e. absence of the initially present bacteria when milk sampling occurs 2 to 4 weeks later) occur in 70-90% of cases in NZ (see Table below). *Strep. uberis* cure rates were in the order of 75-95%, while those for *Staph. aureus* were closer to 25-35% (McDougall 1998; McDougall 2003; McDougall *et al* 2007a, b).

Factors that reduce bacteriological cure rate include isolation of *Staph. aureus* (compared to other pathogens), increasing cow age, increasing days in milk, multiple quarters involved, and where antibiotic resistance is present.

Efficacy of treatment with different antibiotics in NZ

Report	Pathogen	Active ingredient	Route	Number of cases	Bacterial cure rate (%)
McDougall 1998	All	Penethemate	Systemic	157	76
		Penicillin/Dihdyrostreptomycin	Intramammary	185	85
	Strep. uberis	Penethemate	Systemic	126	82
		Penicillin/Dihdyrostreptomycin	Intramammary	151	84
McDougall 2003	All	Lincomycin/Neomycin	Intramammary	73	77
		Penicillin/Dihdyrostreptomycin		73	77
	Strep. uberis	Lincomycin/Neomycin		47	75
		Penicillin/Dihdyrostreptomycin		29	74
McDougall *et al* 2007a	All	Penethemate	Systemic	325	82
		Tylosin		334	84
	Strep. uberis	Penethemate		253	88
		Tylosin		235	90
McDougall *et al* 2007b	All	Pencillin	Intramammary	230	75
		Cefurozime		219	70
		Penicillin/Dihdyrostreptomycin		248	76
	Strep. uberis	Pencillin		117	91
		Cefurozime		92	95
		Penicillin/Dihdyrostreptomycin		115	96

Specific mastitis treatments

The causative bacteria are usually not known at the time of treatment of individual cases so that the choice of treatment is based on the herd history, clinical judgement, and results of recent milk cultures.

Specific antibiotic treatment is indicated when cultures have been performed and the pathogen identity is suspected or confirmed. Some features of treatment of clinical cases caused by common pathogens are listed below:

Strep. agalactiae

- *Strep. agalactiae* is highly sensitive to most of the commonly used antibiotics, and a high cure rate (>90%) can be expected using the correct antibiotic.
- Treatment stops shedding of *Strep. agalactiae* by cows with clinical mastitis.
- Treatment should be part of a total mastitis control programme.

Technote 5 gives a list of actions that should be considered when managing outbreaks of *Strep. agalactiae or Staph. aureus mastitis*

Staph. aureus

- Bacteriological cure rate during lactation is low (about 30-60%) because *Staph. aureus* causes micro-abscesses in the udder, survives inside cells, and some forms are resistant to commonly used antibiotics (e.g. strains with the enzyme beta-lactamase are resistant to penicillin).
- The best hope for successful treatment is in young cows with recent infections (of less than two weeks duration) (Barkema *et al* 2006).
- Treatment of clinical mastitis may reduce *Staph. aureus* shedding, and result in milk returning to clinical normality.
- Use of extended therapy to increase cure rates for *Staph. aureus* has shown positive results (Oliver *et al* 2004; Deluyker *et al* 2005). Studies in NZ (Spatz-Shelgren *et al* 2007; Bryan *et al* 2010), found that doubling the treatment regime from 3 to 6 tubes, administered at 12 hourly intervals, resulted in a 50% cure rate for *Staph. aureus* infections. This was significantly greater than the <30% cure rates observed for cows receiving the standard 3 tube treatment, which was not statistically different from no treatment.

Strep. uberis

- Bacteriological cure rates during lactation are in the order of 70-90%.
- A small proportion of cases are refractory to treatment. Research has found that field strains of *Strep. uberis* are able to invade and live in epithelial cells, which may partially explain why infections are refractory to treatment (Thomas *et al* 1994; Keefe and Leslie 1997).
- Antibiotic resistance is an unlikely explanation for refractory cases. The majority of *Strep. uberis* isolates that have been tested are sensitive to penicillin (>95%), oxacillin (>93%) and cephalithin (99%) (Petrovski *et al* 2011).

Technote 1 gives a list of actions that should be considered when managing outbreaks of *Strep. uberis or E. coli* mastitis

Escherichia coli

- Toxins produced by *Escherichia coli* cause the clinical signs of mastitis. In many cases, bacterial numbers are falling when clinical signs appear.

- Treatment aims to remove toxin by frequent stripping out and use of 30-60 IU oxytocin. To minimise the effects of toxin, use of anti-inflammatory agents and possibly intravenous fluids, may be helpful.
- Systemic antibiotics are given when the cow is extremely ill or when intramammary infusions are unlikely to diffuse through tissue because the udder is greatly swollen.

Supportive treatment

1. Oxytocin

Injection with the milk ejection hormone oxytocin may help remove milk and debris from hard, sore quarters but the value and efficacy of this approach is questionable. Oxytocin is a Prescription Animal Remedy and can only be obtained through veterinarians.

New Zealand research assessed the preventative effect of routine treatment with oxytocin following calving, and found no evidence of prevention of clinical mastitis in heifers (Williamson and Garrett 2010). In a seperate study, across 204 cows with clinical mastitis on 4 farms, oxytocin was found to be a poor treatment for clinical mastitis, with a bacteriological cure rate for oxytocin observed for 42% ($p<0.01$), compared to 64% for antibiotic treatment (Williamson and Garrett 2010).

2. Increased milking frequency

A US study of increased frequency of milk out (6 x daily) accompanied by 20 IU of oxytocin found a reduced cure rate of environmental streptococcal infections, compared to antibiotic treatment alone (Roberson *et al* 2004). A combination of oxytocin and frequent milk out resulted in higher milk yield losses (230 kg) and greater economic losses (US$94) than treatment with antibiotics (Shim *et al* 2004).

A German study compared the effect of milking four times a day with twice a day, in support of antibiotic therapy and could find no difference in cure rates between the treatments (Krömker *et al* 2010).

3. Anti-inflammatories

Non-steroidal anti-inflammatory drugs such as carprofen, flunixin meglumine and meloxicam inhibit prostaglandin production, reduce inflammatory response and reduce pyrexia (Vangreonweghe *et al* 2005). They may have a role in mastitis therapy, particularly where there is toxaemia. A recent study in which meloxicam was added to antibiotic therapy resulted in a reduced SCC and reduced culling of cows compared with antibiotic treatment alone (McDougall *et al* 2009).

Large volumes of isotonic intravenous fluid (25-40 L) can markedly improve the chances of survival of cows suffering from acute toxic mastitis. In the early stages of shock (for example, in cows that had a normal fluid status two hours earlier) small volumes of hypertonic saline have been used as an initial treatment to help restore the circulatory blood volume, provided that they are given with access to water, or oral supplementation of 15-20L of water.

4.8

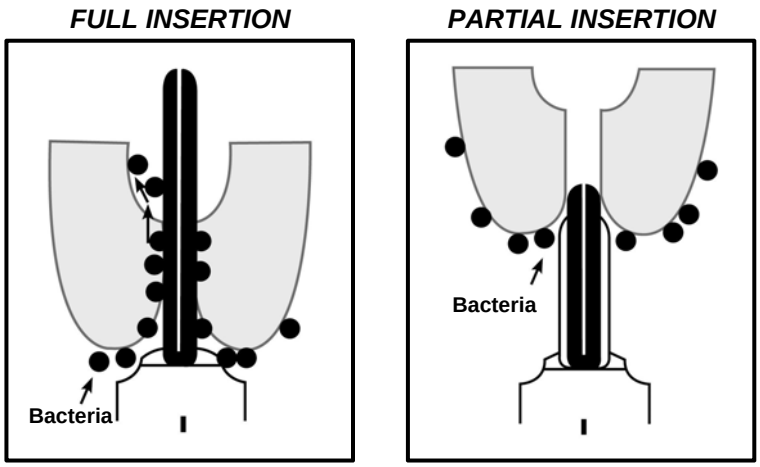
Administer the treatment as recommended.

Administration of intramammary preparations

The nozzle of intramammary treatments can introduce bacteria into teats if the teat end is not properly disinfected. SmartSAMM Healthy Udder provides a pictorial guide of the correct way to administer intramammary treatments.

Ideally, antibiotics are given by partial insertion of short nozzle tubes just inside the teat canal (1-2mm). This is unlikely to be achieved in cows that are not used to having their teats touched, and may therefore not be appropriate for many dairy herds. If an operator is not confident that short nozzle tubes will be used correctly, long nozzle tubes should be used rather than risk damaging the teat canal epithelium.

Use short nozzle tubes if available, or simply insert the tip of the tube just inside the teat canal, to a maximum depth of 3-4 mm.



Administration of intramuscular antibiotics

Standards adopted by the ACVM to prevent carcass downgrades and chemical residue problems are:

- All injections are to be given into the anterior half of the neck
- Some injectable products state maximum volumes that can be injected at any one site. Refer to the label and do not exceed the maximum volume.

This is especially important for dairy cattle that may be culled within 12 months of treatment.

Confidence – High

There is strong evidence that udder infusions can introduce pathogens unless strict attention is paid to sterile technique.

Research priority – Moderate

It is not yet clear when a combination of injectable and intramammary products should be used, in terms of efficacy and economics.

SmartSAMM Healthy Udder provides step-by-step instructions for:

- Administering intramammary antibiotic products.
- Administering intramuscular antibiotic products.

- Demonstration of teat end preparation and intramammary infusion to staff who administer the treatments is worthwhile.
- It is necessary to emphasise that udder cleanliness required for good milking hygiene is not stringent enough for sterile intramammary infusions.

4.9

Use the full course of antibiotics (as specified on the label).

Confidence – High

It is important to use the full course of antibiotic treatment specified by the product manufacturer to reduce the likelihood of infection recurring and to minimise the development of antibiotic resistant strains of bacteria.

Research priority – Low

Efficacy and treatment courses for lactating cow formulations have been established through extensive research for registration of the products by the NZFSA.

Only affected quarters of clinical mastitis cases should be treated. As a significant proportion of cows with clinical mastitis have more than one affected quarter, all quarters should be checked at each milking during the treatment course to enable early detection and treatment of other affected quarters.

Regardless of whether a clinically affected quarter shows rapid improvement, it is important to use the full course of antibiotic treatment specified by the product manufacturer to reduce the likelihood of infection recurring because of inadequate treatment, and to minimise the development of antibiotic resistant strains of bacteria.

The development of antibiotic resistance

There is limited information on the rate that bacteria are developing resistance to antibiotics commonly used to treat infections in food-producing animals.

The likelihood of antibiotic resistance developing broadly depends on the:

- prevalence of resistant bacteria in the animal population;
- frequency of antibiotic use in the animal population; and
- type of exposure to the antibiotics, e.g. short treatment courses of high doses of antibiotic confer less selective pressure than long-term exposure to low doses of antibiotic.

In addition to these factors, the rate of spread of antibiotic resistance within and between animal species will be influenced by the opportunity for contact between animals and the host specificity of bacterial strains. It is, therefore, likely to vary significantly with management systems, mix of enterprise types and geographic location.

One of the few published studies on the change in prevalence of resistant mastitis bacteria is in Finland, where Myllys *et al* (1998) reported an increase of 27% in the proportion of *Staph. aureus* strains resistant to at least one antibiotic (mostly due to strains capable of producing beta-lactamase).

There are no comprehensive longitudinal studies of antimicrobial resistance of mastitis pathogens in NZ. However analysis of laboratory submissions has found that there is a trend to a reduced prevalence of penicillin resistance among *Staph. aureus* (Carmen and Gardner 1997; Petrovski *et al* 2011). Similar findings have been reported internationally (Erskine *et al.* 2002; Makovec and Ruegg 2003).

The NZFSA and the ACVM have a requirement to minimise the emergence of antimicrobial resistance. As such they collate and publish antimicrobial usage and periodically provide reports on risk factors for resistance. These are available from the NZFSA website.

Veterinarians should continue to practice good prescribing principles including treating only those animals with evidence (clinical or microbiological) for infection, use of narrow spectrum antibiotics and continuing treatment for at least 48 hours beyond the end of clinical signs.

Off-label use

Off-label use refers to an unregistered use of a product. This includes any deviation from the manufacturer's recommendations, such as using:

- a different dose rate than stated on the label;
- a different route of administration;
- a different treatment interval or period; or
- a drug for a different purpose to that stated on the label.

Off-label use can only be authorised by a consulting veterinarian and only where legislation permits (McDougall and Millar 2011). It is done at the vet's discretion, taking knowledge of safety and efficacy into account, and is usually restricted to situations where no suitable registered product is available or where scientific evidence supports off-label use.

In food-producing animals, veterinarians prescribing off-label use of drugs become liable for setting appropriate withholding periods. These should be given to the client in writing. Wherever possible, the proposed treatment should be explained to the owner and informed consent obtained before treatment is started.

4.10

Milk the quarter out fully at least every milking.

Section 4.7 describes supportive treatment for clinical mastitis cases.

4.11

Observe withholding times for milk and meat.

Withholding periods (WHP) refer to the *minimum* period of time that must elapse after the last administration of a drug before an animal or its products are sold for human consumption.

Pharmaceutical companies provide recommended withholding periods for their products. Antibiotic residues in milk or meat will not exceed the relevant NZ Maximum Residue Limit if treatments are used according to the label directions and milk or meat are withheld for the specified withholding periods.

Recommended withholding periods are based on trials that specify the:

- class of livestock, e.g. lactating cows;
- dose rate, e.g. milligrams of drug per kilogram liveweight of animal;
- dose interval, e.g. given once daily;
- duration of treatment course;
- frequency of milking, e.g. milked once or twice a day;
- route of administration, e.g. intramammary infusion or intramuscular injection;
- use of drugs within their expiry date;
- use of drugs stored in accordance with label directions; and

- pattern of use for which they are registered, e.g. individual animal treatments.

Non-compliance

For registration purposes, the ACVM requires withholding periods to be based on the product sold for consumption. Consequently, withholding periods for intramammary antibiotics for lactating cows refer to cows and calves sold for meat or vats of milk.

In NZ, failure to observe withholding periods after treatment is the most significant cause of residue non-compliance (Beal 2002, Heuer *et al* 2003, McDougall *et al* 2004). In dairy cattle, antibiotic violations are often associated with:

- inadvertent use of antibiotic DCT in lactating cows (note that antibiotic DCT is registered for use only immediately after a cow's last milking for a lactation);
- failure to identify treated cows;
- failure to record treatment dates;
- cows treated with antibiotic DCT at drying-off inadvertently re-joining the milking herd;
- calving of cows treated with antibiotic DCT before expiry of the Minimum Dry Period;
- 'off-label' drug use.

Any deviation from the registration specifications described above may lead to changes in the withholding periods for a product. Such changes are unlikely to be linear (e.g. doubling the dose cannot be extrapolated to a simple doubling of the required withholding periods) (Whittem 1997; McDougall and Millar 2011).

When giving systemic treatments for mastitis it is important to calculate the correct dose, as withholding periods for milk and meat change markedly when drugs are used at higher dose rates than specified on the label. Weights can be measured on scales or by using girth measurements and height sticks as a guide.

High dose rates constitute an 'off-label' dosage and, for any prescription drug, can only be considered with written permission from a veterinarian. They are a common cause of antibiotic violations.

Once daily milking

A number of intramammary antibiotics (e.g. penicillin and cloxacillin) now have specific 'on label' withholding times for use when milking cows once a day. Where herd owners are milking cows once daily, veterinarians should only prescribe registered products, to remain 'on label'.

Herds in which cows are milked once daily should use products that have withholding periods recommended for use in cows milked once daily.

Antibiotic residue tests

Traces of antibiotic in milk may cause allergic reactions in people and inhibit some starter cultures used in yoghurt and cheese production. National and international regulations stipulate the maximum levels of antibiotics that may be present in milk and these thresholds are often extremely low. The NZ limit is 0.003IU/ml penicillin or equivalent (DPC2: Animal Products (Dairy) Approved Criteria for Farm Dairies) and a full list of allowable limits is available from NZFSA.

Dairy companies perform regular screening tests to detect antibiotic residues (as inhibitory substances) in the vat milk that they collect. This occurs at several levels:

- Screening of tankers before unloading using a rapid inhibitory substance screening method such as Charm SL Strips (Charm Sciences Inc) or Twinsensor (Unisensor Ltd). If the tanker is found to contain detectable levels of inhibitory substances then all suppliers on the tanker will be tested at the laboratory to identify the supplier or suppliers responsible.
- Screening of individual supplier milks using a bacterial inhibition assay such as Copan CMT (DSM Food Specialists) or Delvo SPNT (DSM Food Specialists), to detect any substance that is inhibitory to the test bacteria. This is required by the NZFSA at least once every 10 days.
- An independent survey of bulk raw milk for antibiotic (and other) residues, called the National Chemical Contaminants Programme. This service provides a credible monitoring system that helps the NZFSA to sign off on European Union exports.

Technote 3 describes common risks for inhibitory grading of the bulk tank.

Milk should be withheld from the vat if there is any suspicion that it contains antibiotic residues. Milk from a single quarter can contaminate an entire vat or tanker. Milk quality advisors can check vats before supply if there is any question.

All dairy companies will conduct rapid tests on farm if there are concerns that antibiotics may have contaminated the vat.

These tests should not be used on individual cows because they have been designed and validated for use on bulk milk. It is possible for false positive test results to occur if they are applied to individual milk samples. For example, non-specific inhibitory substances present in the milk of freshly calved cows or clinical mastitis cases are likely to give a positive Delvotest® SP test result (Cullor *et al* 1993; Andrew 2000; Andrew 2001).

Inhibitory substances and antibiotic residue detected in an individual milk sample may not be excessive once diluted with clean milk in the vat. However, following a violation, on-farm testing of bulk milk is strongly recommended using factory screening tests.

Screening tests are relatively non-specific and vary considerably in their ability to detect all antibiotic families. A more sophisticated and expensive method for quantifying and identifying the type of antibiotic present is Liquid Chromotagraphy Mass Spectroscopy (LCMS). This test is recommended when investigating inhibitory grades where the source of antibiotics is unclear.

4.12

Discard milk from all quarters of cows that receive treatment.

Even when a single quarter has been treated with intramammary antibiotic, it is possible that some antibiotic will be absorbed into the bloodstream and pass into the milk of normal quarters. The risk of antibiotic contamination is too great to include milk from treated cows in the vat. Do not use quarter milkers.

Milk that is subject to a withholding time must be harvested and stored in such a way that there is no risk of it mixing with, or cross-contaminating, milk intended for human consumption.

The withheld milk is not to be used for:

a) human consumption,
b) fed to calves or other animals intended for slaughter for human consumption within 28 days following feeding.

It may only be fed to animals when in compliance with the Agricultural Compounds and Veterinary Medicines Regulations 2001 (NZFSA 2011).

The accepted best practice is to run all treated cows in a separate herd and in a secure paddock. These cows must only be brought to the farm dairy when all the milking cows have been milked and have left the dairy. Prior to milking the treated cows, the operator must ensure that the milk delivery line is disconnected from the milk vat.

If milk is harvested from cows under treatment or under a withholding period, and stored in a vat in the milk collection area, then this vat needs to be clearly labelled as not 'fit for supply' and the vat outlet must be locked to ensure that the milk cannot be collected by mistake. All operators should know how treated milking animals are identified, and the process to follow if they are accidentally milked into the vat for supply.

Consumables such as gloves, teat wipes and milk filters, must be stored in such a way that there is minimal risk of contamination with veterinary medicines.

4.13

Consult your veterinarian for advice if a clinical quarter fails to respond by the end of a full course of treatment.

The reasons why a clinical quarter may fail to respond to treatment need to be considered when deciding the next course of action. These may include:

- Inappropriate choice of drug.

Drugs which do not have the spectrum of activity required to combat infections in a particular herd will be ineffective. The pharmacological properties of some drugs make them inappropriate for use in mastitis therapy. For example, although some drugs are effective *in vitro* they may be ineffective *in vivo* if they are unable to cross to the site of the infection.

- Physical obstruction preventing drugs reaching the site of infection.

Examples are accumulations of inflammatory cells and hyperplasia of alveolar epithelium. Infections such as by *Staph. aureus*, can lead to fibrosis and formation of micro-abscesses within the udder. Many antibiotics are unable to cross these barriers in sufficient concentration to reach the minimal inhibitory concentrations required at the site of infection.

- Attributes of the bacteria.

Staph. aureus bacteria, sensitive *in vitro* to the antibiotic used, may gain refuge within the acid phagolysosomes of macrophages and polymorphonucleur neutrophils within the udder. Antibiotic penetration of cells may be poor and even if they gain access to the cell, they may not distribute to the phagolysosomes.

Other organism-related reasons for treatment failure include infections that

- If a milk sample was collected and frozen before the initial treatment, it can be cultured to determine the causal bacteria and their antibiotic resistance.
- Pathogens introduced at the time of treatment (due to poor technique when giving intramammary infusions) will only be identified by resampling the quarter.

are resistant to useable antibiotics (e.g. *Pseudomonas*, mycoplasma, yeasts, etc.) and the emergence of L-forms ('naked' acapsular forms that resist beta-lactam antibiotics).

Options when there is no response to treatment

Options that can be considered when a clinical quarter fails to respond to a full course of treatment include the following:

Repeating the treatment but treating for an extended time with the antibiotic.

There is emerging evidence that 'extended' therapy (i.e. 6 to 8 treatments) with time dependant antibiotics such as the beta lactams will result in improved cure rates (Oliver *et al* 2004; Deluyker *et al* 2005; Spatz-Shelgren *et al* 2007; Steele *et al* 2010). However economic analysis suggests that extended therapy may not be economic in all situations (Steeneveld *et al* 2011)

Some products are registered for extended therapy (generally up to 6 treatments). Individual prescriptions will be required for extending therapy with other products. Note that repeated treatments will extend the required withholding periods.

Trying a different antibiotic treatment.

It is generally more effective to extend therapy, rather than change product. However if new information comes to light (e.g. culture results), an alternative may be more appropriate.

The longer a case of clinical mastitis persists, the greater the degree of fibrosis and abscessation that may occur, and the less likely the quarter is to respond to antibacterial treatment. Some cases just do not respond to treatment, even if the bacteria are sensitive to the product.

Drying-off the infected quarter if it is not hot and swollen.

This is an option if the cow is in good general health apart from the infected quarter. A simple method of drying-off a quarter is to stop milking the quarter, as long as it is monitored to ensure that it does not develop into an acute case of mastitis. Cessation of milking should be delayed until the end of the withholding period after administration of the last treatment.

It is important that these quarters are permanently identified to prevent accidental attachment of cups to these teats at the time of milking. Antibiotic DCT must not be used in a quarter when the other quarters are continuing to be milked. Antibiotic DCT products are not registered for use in lactating cows. Some antibiotic will be absorbed into the bloodstream and passed out in the milk from the normal quarters, so there is an unacceptable risk of antibiotic contamination of the vat.

At the end of lactation it is not appropriate to use antibiotic DCT in a quarter that has been dried off during lactation because intramammary DCT will not be absorbed by dry glands. Advisers may consider using injectable antibiotics at the end of lactation in these cows, but there are no registered products, or peer reviewed data, to support this approach.

If the gland fails to stop producing milk after some weeks of cessation of milking, through not applying the cups, alternative strategies may be considered. These strategies are intended to permanently dry off the quarter while retaining the cow in the herd with three viable quarters. These

procedures should only be performed by a veterinarian. Options include:

- Infusion of an irritant into the affected quarter to produce a chemical mastitis that causes it to permanently dry-off. The recommended approach is iodine (5%, up to 120 mls; Middleton & Fox 2001), usually with concomitant treatment with an anti-inflammmatory. This needs to be performed under PAR and milk must be withheld from the vat for an appropriate period. Use of chlorhexidine diacetate (Boddie and Nickerson 1994) or 5% copper sulphate have also been reported, but there are few anecdotal reports of success.
- Surgical removal of the teat, undertaken by a veterinarian, with appropriate pain relief.

From an animal welfare perspective, the short-term inflammation caused by the chemical cauterisation treatment may be preferable to the long-term inflammation and other potential problems associated with chronic mastitis. It is notable that most farmers do not report any significant drop in production of the other three quarters following treatment.

Drying-off the affected cow.

Drying-off cows with quarters that fail to respond to treatment removes a source of infection to other cows in the milking herd. These cows may be treated with antibiotic DCT and the affected quarter closely monitored – if the quarter becomes hot and swollen, or the cow becomes systemically ill, treatment with lactating cow antibiotic product in the infected quarter may need to be reinitiated.

Culling chronically infected cows from the herd.

Culling chronically infected cows is an important component of any mastitis control programme. The recommended withholding period for meat must be observed if the cow has been treated with antibiotics.

Technote 15 describes mastitis criteria for culling cows

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