

## 7

## Use post-milking teat disinfection – spray or dip every teat at every milking

Milk from infected quarters contains bacteria that may contaminate the skin of many other teats during milking. *Staph aureus* or *Strep agalactiae* in milk from an infected cow may be found on the teatcup liners and transferred to the teat skin of the next 5-6 cows that are milked with that unit. Once on the teat skin, they multiply (especially at sites of teat lesions) and so increase the risk of infection of the quarter via the teat canal. Teat disinfection helps keep teat skin healthy and heal skin lesions, and these actions may be its most important contribution to mastitis control (Hillerton 1997). Many field experiments have shown that effective post-milking teat disinfection lowers new infection rates of the cow-associated mastitis bacteria (*Staph aureus* and *Strep agalactiae*) by 50% or more (Bramley 1992). Recent field observations in New Zealand have demonstrated a similar reduction in new infection rates with the environmental pathogen *Strep uberis* (Woolford 2001).

Routine post-milking teat disinfection has been, and still is, the single most effective component of hygienic milking programs used in the United States, United Kingdom and Australia. However, it has not been universally adopted in all countries. Several Scandinavian countries rely on laboratory-based mastitis control systems where milk samples are regularly monitored, and post-milking disinfection is only recommended for problem herds.

The majority of Australian dairy farmers rely on post-milking teat disinfection, applied by a spray technique, as an integral part of their mastitis control programs (Lee 1994). Spraying is preferred because it is considered to be quicker and easier. Most research on teat disinfection has used teat dipping as the method of application. A field trial in five herds in New Zealand in 2001 established that spray application can be equally effective (Woolford 2001).

Post-milking teat disinfection aims to:

- maintain healthy skin; and
- reduce the bacterial population at the teat orifice and on the areas of teat skin that have come into contact with the teatcup liner during milking.

There is no benefit from disinfecting any part of the udder surface apart from the teat skin. It is, however, important that the entire teat barrel (everywhere the liner has touched) is disinfected and not just the teat end. Efficient application of teat disinfectant is essential. All the benefits of correct product selection, preparation and handling are lost if the teat disinfectant does not reach the teat skin.

The 'Pre-milking teat disinfection' FAQ sheet discusses the use of this technique overseas to control environmental bacteria.

The Countdown Downunder Mastitis Model is a stochastic computer model that simulates dynamics and economics of mastitis and mastitis control strategies in dairy herds.

Revised Technote 13 (February 2003) contains a Mastitis Investigation Pack that has key questions about teat disinfection on Sheets G and L.

The impact of post-milking teat disinfection on herd mastitis prevalence occurs over the medium to long-term. Simulation modelling can be used to isolate the effects of individual changes in complex systems. A computer model of mastitis developed by Countdown Downunder shows that reducing teat disinfection efficiency by 50% for one year (for example, by poor spraying technique) in a herd with an annual average bulk milk cell count of about 200,000 cells/mL, leads to an increase in cell count of approximately 100,000 cells/mL. Elevated cell counts then continue for two to three years with the loss of between \$10 and \$20 per cow each year.

Investigation of mastitis problems usually requires an assessment of the whole teat disinfection process, including the product used, its preparation, storage and handling on the farm, and the method and efficiency of its application to teats (Ryan 1991). Common problems are:

- failure to mix to label recommendations;
- failure to measure components accurately;
- addition of inappropriate emollients;
- use of poor quality water;
- incorrect or prolonged storage of teat disinfectants; and
- inadequate coverage of the teat skin.

The presence of *Corynebacterium bovis* in a herd is a warning sign of inadequate teat disinfection (Bramley et al 1976). Spread of *Corynebacterium bovis* is easily prevented in herds by effective post-milking teat disinfection. Once *Corynebacterium bovis* has colonised a quarter it usually remains until antibiotic is administered (for example, as Dry Cow Treatment). If the teat disinfection regimen is improved, *Corynebacterium bovis* can still be cultured until after cows are treated at the end of their lactations.

## 7.1 Use a teat disinfectant registered by the National Registration Authority.

The National Registration Authority (NRA) is the organisation that controls importation, manufacture and supply of agricultural and veterinary chemicals in Australia. Chemicals used in agriculture in Australia must be registered with the NRA (unless used in special circumstances, such as under veterinary prescription or on research permit).

Registered products are issued with a unique NRA Label Approval Number and are required to display this on the product label. For example, a label would show a number such as 'NRA Approval Number 49123/0202'.

### *Product registration*

Companies wishing to register a product with a new active ingredient must demonstrate its effectiveness, safety with respect to human and animal health, environmental impact and its likely impact on trade, all related to use of the product within the Australian dairy industry. The NRA guidelines for evaluation of product efficacy and safety for cows can be obtained from the NRA website ([www.nra.gov.au](http://www.nra.gov.au)). They include testing the product for its irritancy on teat skin under 'normal' and 'adverse' Australian climatic conditions and its effectiveness in reducing the number of naturally occurring new mastitis infections. Data from laboratory and field research are required. Overseas research results may be presented, but Australian data are often required as supporting evidence. Details are also required about the ingredient, including its chemistry and manufacture, toxicology, metabolism, and residues. For a generic product (patterned on an existing registration), the information required depends on how closely it resembles the existing product and its intended use.

Companies invest considerable resources in registering products and manufacturing them under Good Manufacturing Practice guidelines.

### *Unregistered products*

Unregistered products can be identified by the fact that they have no NRA Approval Number on the label and are not on the NRA database. A company which supplies unregistered products can be fined up to \$150,000. The product concerned may also be subject to national recall. The NRA does not undertake routine inspection to detect unregistered products but relies on reports from industry and the public. Approximately 300 reports are received by the NRA each year. Reports are assessed on likely risk and prioritised for follow-up.

Farmers using unregistered products risk applying ineffective treatments, having chemical residues in milk or meat, and causing harm to the environment, human health or animal health.

Farmers and advisers should report unregistered or non-compliant products or advertising to the NRA via its website (see [www.nra.gov.au](http://www.nra.gov.au) for the report of unregistered product) or by contacting the NRA compliance officer by phone, (02) 6272 3450.

### **Confidence – High**

Before any product can enter the Australian market, it must go through the National Registration Authority's rigorous assessment process to ensure that it meets high standards of safety and effectiveness. Any changes in formulation or use of a product that is already on the market must also be referred to the NRA.

### **Research priority – Moderate**

There may be some need to streamline the protocols applied to the assessment process in the current registration procedures.

The NRA maintains a list of registered products on its website [www.nra.gov.au](http://www.nra.gov.au). Consumers may also contact the NRA by phone, (02) 6272 3744, to obtain information on the registration details of specific products.

### **Reporting adverse experiences with products**

The NRA also runs the Adverse Experience Reporting Program (AERP) to collect information on adverse reactions to registered products.

In most instances, registered agricultural and veterinary chemicals serve us well. Occasionally, unforeseen problems arise from the use of these compounds that may affect people, animals, the environment or trade. The NRA seeks to identify and act promptly on such adverse experiences.

Farmers and advisers should report any adverse experiences to NRA, via its website (see [www.nra.gov.au](http://www.nra.gov.au) for the adverse experience reporting form), or by contacting the AERP Co-ordinator by phone, (02) 6272 3651.

### **Active ingredients in teat disinfectants**

More than 10 different active ingredients have been used in teat disinfectants throughout the world over the past 20 years. The National Mastitis Council in the United States has reviewed and summarised all the scientific literature on teat disinfectants published since 1980 (National Mastitis Council 2001).

Active ingredients used in products currently available in Australia are:

- iodine;
- chlorhexidine;
- acid anionic compounds (alkyl benzene sulphonic acid); and
- hydrolysed linseed fatty acid.

#### ***Iodine***

The iodine-based teat disinfectants are commonly known as iodophors because in the past many contained phosphoric acid. There are many formulations of iodophors on the Australian market. They incorporate an organic iodine complex (the active ingredient) and different combinations of complexing agents, surfactants, detergents and emollients.

The antimicrobial spectrum of iodophors includes bacteria, viruses and fungi. They destroy microorganisms by chemical action through oxidation/reduction mechanisms that interrupt protein synthesis, nucleotide and lipid membrane structure. Iodophors also react with dead and decaying material so their germicidal capacity is depleted when they are exposed to high levels of organic matter.

The concentration of 'available iodine' is the total iodine that is measurable (titratable) in the solution. For example, a concentrate labelled at 20 grams per litre (2%) and diluted 1:3 will have 0.5% available iodine. This is in a complex form that is not itself germicidally active. In each solution, some iodine occurs as 'free iodine' in equilibrium with the complex, and this is the germicidally active form. As free iodine is consumed, more is released from the inert form. Unlike available iodine, free iodine levels are difficult to measure, but it is possible to do so, for example by potentiometric techniques.

Iodophor teat disinfectants have no germicidal activity after the solution has dried on the teat surfaces. The required contact times for effective bacterial killing by iodophors may vary from 5 seconds to 10 minutes. These times can be reduced by the incorporation of other agents, such as surfactants, to improve the wetting

properties of the disinfectant mix and help its penetration into organic matter and bacterial cells.

Iodophors should be acidic (pH <6.5) to provide for iodine stability. Exposure to acidic solutions has the potential to irritate teat skin. Some products on the Australian market have a pH of less than 4 when made up as the final solution and the addition of emollients in manufacture helps prevent irritation and maintain teat health.

### **Chlorhexidine**

Chlorhexidine is a colourless, odourless organic compound which is soluble in water. It is used at 0.5% concentration and a dye is commonly added to commercial products to allow the solution to be seen on teat skin.

The antimicrobial activity of chlorhexidine is primarily against bacteria, with variable effect against viruses and fungi. Some bacteria which can cause severe mastitis are able to survive in chlorhexidine, for example *Pseudomonas aeruginosa* and *Serratia marcescens*. Chlorhexidine is adsorbed onto the surface of bacterial cells leading to rapid coagulation inside the cell and cell death.

Chlorhexidine is a positively charged (cationic) molecule that readily complexes with organic anions or other negatively charged molecules, such as carbonate, sulphate, phosphate and chloride. When chlorhexidine is mixed with water that is 'hard', high in organic matter, or has been treated with chlorine, insoluble salts are formed and its bactericidal effect is reduced. Reduction in bactericidal activity of chlorhexidine begins when water has a hardness of 20 parts per million. When water hardness is above 200 parts per million, chlorhexidine is entirely precipitated and inactive. The optimum pH range for chlorhexidine is 5.0-8.0 (Denton 2001). Emollients are often used in conjunction with chlorhexidine to enhance teat health.

### **Acid anionic compounds**

The active chemical ingredients in acid anionic disinfectants are anionic surface-active agents. These compounds display rapid (30 seconds) bactericidal action on a number of bacteria, and are effective against viruses and fungi. It is known that at least one active ingredient (dodecyl benzene sulphonic acid) in this class of teat disinfectants does not control *Corynebacterium bovis* or coagulase negative Staphylococci (National Mastitis Council 1999).

The germicidal action of acid anionic disinfectants is not fully understood but is thought to be due to their ability to disrupt cell membranes, inhibit enzymes and denature cell proteins. A pH range of 1.5 to 3.0 offers the optimal acidity for effective antimicrobial action of these products. As the pH increases beyond 3, the bactericidal activity decreases rapidly, reaching a minimum at neutral or slightly alkaline pH. Alkalinity up to 900 parts per million can be tolerated (Dychdala et al 1991). Hardness should not exceed 400 parts per million. Emollients are added

in product manufacture to maintain and improve teat health.

### ***Hydrolysed linseed fatty acid***

There are no publications in the scientific literature describing the mechanism of action or the efficacy for this compound. Studies conducted to satisfy registration requirements indicate that hydrolysed fatty acids function as teat disinfectants by disrupting the integrity of bacterial cell membranes and inhibiting the growth of microorganisms.

Adverse reactions were recorded when this group of teat disinfectants were diluted with water that was heavily contaminated with bacteria. The suggested pH range for water used to mix this product is 6-8.

### **Resistance to disinfectants**

Bacterial resistance to disinfectants is not recognised as a problem at present. However, there is experimental evidence that particular bacteria do have the capacity to develop resistance to some disinfectants including chlorhexidine diacetate (Tattawasart et al 1999).

Resistance to disinfectants may be more likely to develop if they are used at concentrations lower than required for optimal biocidal effect. This reinforces the importance of always using disinfectants at the recommended concentrations and according to the label directions. There is no evidence to suggest that rotation of active ingredients in teat disinfectants is warranted on farms.

## Selection of a teat disinfectant on farm

Farmers should regularly review their satisfaction with the teat disinfectant they are using and avoid making snap decisions about product selection at the time of purchase. Factors to consider are:

### Effectiveness:

In general the industry relies on the NRA's registration process to establish that all products available on the market are effective in Australian dairying conditions. Published information on product efficacy is usually available from the product manufacturer. Particular recommendations may be made by advisers in special circumstances. For example, a herd experiencing a mastitis outbreak with a pathogen such as *Pseudomonas aeruginosa* may be advised to avoid using a chlorhexidine product.

### Suitability for a given farm water quality:

Some active ingredients in teat disinfectants have reduced biocidal activity and form precipitates which block spray equipment when mixed with water that does not have compatible characteristics.

Technote 7.3 gives a guide for selection of the most appropriate product type when water quality is known.

### Occupational health issues:

Adverse reactions in milking staff such as skin reactions (on the hands and exposed skin), respiratory and conjunctival problems may be the result of an allergic response to an ingredient in a product, or may result from heavy exposure due to faulty settings or siting of spray equipment or poor operator technique. The method of use should be assessed and the type of disinfectant may need to be changed if any staff members have adverse reactions. A review is appropriate whenever new staff begin milking.

### Teat skin reactions:

Teats should be regularly checked to ensure the skin is supple and in good condition. Corrective changes may involve altering the concentration of emollient or changing the product. It is important to closely monitor changes whenever a new product is used.

### Visibility:

Teat disinfectants which are visible on the teat skin enable operators to more easily assess their success in achieving good teat coverage. Technote 7.6 outlines the issues to be addressed regarding application.

### Price:

There is considerable variation in the shelf price of teat disinfectant products. To compare the prices it is helpful to calculate the cost per cow per milking (given that, for spray application, Countdown recommends using 20 mL of solution per cow per milking).

For example: Product X is an iodine concentrate (iodine 20 g/L) in a 20-litre drum which costs \$110 including GST, and must be diluted 1 part to 3 parts water to make up 80 litres of final solution.

Nett cost = \$100

Cost / litre of final solution = \$100 / 80 litres = \$1.25

Cost / mL = \$1.25 / 1,000

Cost / 20 mL = \$1.25 / 1,000 x 20 = 2.5 cents

Cost per cow per milking = 2.5 cents

### Shelf life:

When purchasing teat disinfectant products (either in concentrate or ready-to-use form), farmers should ensure that the quantity purchased will be finished prior to the expiry date specified on the label.

### Milk residues:

In general, the industry relies on the NRA's registration process to establish that no product available on the market leaves unacceptable milk residues when used according to the label directions.

There have been no problems identified in Australia of iodine residues in milk associated with normal use of iodophor teat disinfectant, even when only some cows have their teats washed before the next milking. But, if particular farms experience high milk iodine levels at certain times of the year (for example, because of high iodine intake in food or water) teat disinfectants with other active ingredients may be chosen. For more information see the 'Iodine milk residues' FAQ sheet.

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**Confidence – Moderate**

The recommendation to mix a fresh batch of disinfectant each day provides a safeguard to ensure stability and efficacy of the teat disinfectant solution.

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**Research priority – Low**

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See Technote 7.3 for methods of testing teat disinfectant mixes.

## 7.2 Mix a fresh batch every day.

Dairy farmers in Australia prepare the majority of teat disinfectant solution from products purchased as concentrates. There are now also a number of ready-to-use products registered and on the Australian market.

Whether the concentration of the active ingredient in teat disinfectant's final mix is maintained for hours, days or weeks depends on a complex interaction of factors – including the amount of water in the mix, the quality of the water used, the original concentration of the active ingredient and the ambient temperature. Some solutions remain stable for long periods under excellent storage conditions (e.g. mixed with pure water and stored in a sealed container kept at less than 30°C). In the case of iodine, the rate of loss of iodine is doubled when the mixed solution is stored at 40°C compared with 30°C or less. The level of available iodine is also reduced if containers are not sealed tightly, water quality is poor, inappropriate emollients (such as bloat oil) are added, or if the solution is contaminated with milk, dirt or other organic matter.

When they mix solutions, Australian farmers use water of varying quality and add emollients to the chemical concentrate. For these reasons, it is difficult to predict the stability of teat disinfectants mixed on farms. Countdown Downunder provides a 'safety net' by making a blanket recommendation: when using concentrate products, mix a fresh teat disinfection solution each day.

When the ready-to-use products were registered the products were closely scrutinised for disinfectant stability during the product shelf life. Field testing of the initial ready-to-use product registered in Australia has shown good stability on farms, provided the product is stored according to label directions (below 30°C, out of direct sunlight and in the original closed container). Field experience with large volume storage containers (over 1,000 litres) is limited. Stability of iodine disinfectants may be reduced if there is a large volume of air in a container, even if it is sealed.

### 7.3 Use water of very high quality

Because teat disinfection is such a significant part of preventative action in mastitis control, it is important to be confident that the final mix being applied to teats is effective. Field examination of many teat disinfectant mixes (in mastitis investigations and during Countdown Farmer Short Courses) has demonstrated them to be of poor quality. For example, only 35% of 162 farmers at recent Countdown courses had mixed iodine-based teat disinfectant solutions to achieve 0.5% available iodine.

The water used in mixes is of particular concern. Water quality varies greatly around Australia, containing differing levels of suspended matter (such as decaying vegetation, algae, clay, and bacteria), minerals and dissolved gases. Regular testing is advised, especially when the water source or quality changes.

#### **Water quality characteristics that alter effectiveness of teat disinfectants**

A number of water quality characteristics alter the bacterial killing power of teat disinfectants - particularly alkalinity, water hardness, organic matter, and chlorine concentration.

- Alkalinity is a measure of the buffering capacity of water and is expressed in parts per million of calcium carbonate ( $\text{CaCO}_3$ ). Field test kits and laboratory confirmatory tests for alkalinity use acid-base titration techniques. Water with alkalinity greater than 500 parts per million greatly reduces the concentration of available iodine for iodophor teat disinfectants.
- Hard water has high levels of cations such as calcium, magnesium and manganese. Hardness is expressed in parts per million calcium carbonate. Field test kits are based on titration, and laboratory tests are performed with electrical conductivity meters or by a technique called Inductively Coupled Plasma. It is important to check numeric values when assessing hardness. A recent International Dairy Federation review showed that the terms 'very soft', 'soft', 'hard' and 'very hard' are applied at many different thresholds. Reduction in bactericidal activity of chlorhexidine begins when water has a hardness of 20 parts per million. When water hardness is above 200 parts per million, chlorhexidine is entirely precipitated and inactive.
- Organic matter is assessed in the field by visual and olfactory examination of the water. Laboratory tests are based on combustion techniques which measure total organic carbon or chemical oxygen demand. Organic matter consumes free iodine and linseed fatty acid products are broken down when mixed with water with high bacterial loads. Chlorhexidine forms insoluble salts with organic acids and tannins. There should be no colour, sediment, suspended solids or smell to water being used to make up any teat disinfectant.
- Chlorine in water can be assessed by dip-stick field test kits and by chromatography in the laboratory. Chlorinated water forms an insoluble salt with chlorhexidine. It is not known to cause a problem with iodophors, acid anionics or hydrolysed linseed fatty acid.

#### **Confidence – High**

The active ingredients of teat disinfectants are adversely affected by poor water quality.

#### **Research priority – Moderate**

Farmers and their advisers need ready access to appropriate on-farm and laboratory water quality tests. Practical methods of providing high quality water for many tasks in dairies (making up teat disinfectants, preparing udders and washing equipment) should be evaluated.

When assessing water quality reports, check the parameter being described as both alkalinity and hardness are measured using the same units (parts per million  $\text{CaCO}_3$ ). The buffering capacity of a solution is expressed as carbonate content ( $\text{CO}_3$ ) and its hardness is expressed as the concentration of calcium cations ( $\text{Ca}^{++}$ ).

#### **Australian standards for 'potable' (drinking quality) water**

pH: 6.5-8.5

Hardness: <200 ppm

Alkalinity: Not specified

Organic matter:

- Total dissolved solids <500 mg/L,

- Total filtered solids <100 mg/L

Total coliforms: 0/100 mL

Chlorine: <0.6 mg NaCl/L

Some companies which supply field test kits or provide field testing services are:

**Campbells Cleantec**

32 Perivale St, Darra, Qld 4076  
Phone 1800 077 240

**Daviesway – Boumatic**

15 Helen St, West Heidelberg,  
Vic 3081

Phone (03) 9459 4533

**DeLaval Pty Ltd**

1 Global Drive, Westmeadows,  
Vic 3043

Phone (03) 9335 6061

**Ecolab**

350 Reserve Rd, Cheltenham,  
Vic 3192

Phone 1800 022 002

**Hach Company**

c/- Selby Biolab,  
2 Clayton Road, Clayton, Vic 3168

Phone 1300 550 225

**Tasman Chemicals**

2-6 Roberna St, Moorabbin,  
Vic 3189

Phone (03) 9555 8033

**The Merck Company**

207 Colchester Road, Kilsyth,  
Vic 3137

Phone (03) 9728 5855

Although iron compounds (which are very common in bore water) can cause problems in dairy plant cleaning because they form deposits in milk equipment, they appear to have little impact on the registered teat disinfectants.

The source of water often suggests what sorts of impurities it may contain. As examples, town water can have high levels of chlorides as a result of treatment. Surface water, from creeks and dams, is often high in organic and inorganic material and varies dramatically in composition - from being stagnant after periods of low rainfall or containing run-off after heavy rain. Many rainwater tanks in Australia contain surprisingly high levels of organic matter (such as decaying leaves, dried dust and manure, and bacteria), especially in regions where there is little summer rainfall and where dairy shed roofs are used as catchments. Water stored in concrete tanks can be alkaline. Channel water may be very high in colloidal content (clay particles). Groundwater from some areas in South Australia is extremely alkaline. In the Hunter Valley, water hardness may change from 200 to 2,000 parts per million overnight as water is released from regional mining industries activities. A warning should also be noted about rainwater tanks – when water levels become low, they are commonly topped up from the bore, channel or other sources, so tank water is often not rainwater at all.

Using cooled water from the hot water service minimises the risk of bacterial load. Provided the water that goes into the heater does not have inappropriate alkalinity, hardness or chlorine levels for the active ingredient used, this may be a good source of water for mixing teat disinfectants.

If the quality of water available at the dairy is not adequate, farmers are advised to consider an alternative water supply, such as distilled water, de-ionised water or potable water from the farm house, to make up teat disinfectant, or to purchase a ready-to-use product.

### ***Testing the final mix of teat disinfectant solutions and water on farms***

It is clear that for teat disinfectants that are mixed on farms, it is important to regularly test the level of active ingredient in the final mix (if possible), and the water used. Advisers need access to testing kits or laboratories that can perform tests, and guidelines on how to interpret the results.

The logical path for field testing is to first check the active ingredient in the mix (this is only possible at present for the iodine-based products). If the level of the active ingredient is within the acceptable range, no further testing is required.

If there are no field tests available to measure the active or levels are unacceptable, it is appropriate to check that the water being added to the mix is suitable for the chosen active.

Most of the field tests are available as kits designed to be used on-farm. The cost per test is approximately \$2 for each component analysed (available iodine, alkalinity, hardness and chlorine).

Be aware of the limitations of field tests – they are an indicator only. Only use tests that are designed to provide results appropriate for the type of assessment and range of expected results (for example, the acid base titration kits are designed to test diluted iodine, not concentrate).

Tips for using test kits in the field include:

- Do not use tests or reagents which are past their expiry date or have not been stored according to label directions.
- Conduct tests on well mixed solutions.
- Use clean, dry containers.
- Test samples on the day of collection if possible.
- Take care to avoid direct heat (greater than 40°C) during storage or transport.
- When using reagent dropper bottles, always hold the bottle vertically, to ensure consistent drop size.
- Ensure consistency in reaching colour change endpoints (for example, holding the sample against a white background will assist).

Confirmatory tests are advised when field tests are not available and a real problem is suspected based on farm history, or if repeat field testing gives widely variable results or results that are difficult to interpret in the light of other observations.

More sophisticated water testing may be obtained from local water authorities or independent laboratories. These authorities can often provide advice on water treatment options in each region. Many of the manufacturers of registered teat disinfectants offer a water and active ingredient testing service, provided at

### Assessing the level of active ingredients in teat disinfectant solutions applied to teats (as the final mix or ready-to-use solution)

	Chlorhexidine	Iodine	Acid anionics	Hydrolysed linseed fatty acid
What concentration of active ingredient is required?	Not less than 0.5% chlorhexidine	Not less than 0.5% available iodine	Not less than 2% acid anionic	Not less than 5% hydrolysed linseed fatty acid
How can it be tested in Australia?	No field tests available. Laboratories confirm levels by High Pressure Liquid Chromatography (HPLC)	Field test kits use sodium thiosulphate titration. Laboratories confirm levels by potentiometric titration	No field tests available. Laboratories confirm levels by High Pressure Liquid Chromatography (HPLC)	No field tests available. Laboratories confirm levels by Gas Chromatography

### Assessing the suitability of water used to mix teat disinfectant solutions on farms

	Chlorhexidine	Iodine	Acid anionics	Hydrolysed linseed fatty acid
Alkalinity	No specific recommendations available	Should not exceed 500 ppm CaCO <sub>3</sub>	Should not exceed 900 ppm CaCO <sub>3</sub>	No specific recommendations available
Hardness	Should not exceed 200 ppm CaCO <sub>3</sub> . Decline in effectiveness of chlorhexidine may begin above 20 ppm.	No specific recommendations available	Should not exceed 400 ppm CaCO <sub>3</sub>	No specific recommendations available

minimal cost. The experience and expertise of technical staff in these companies can be a valuable resource in troubleshooting problems with teat disinfection.

If further tests are required for confirmation, collect 250 mL of water, 250 mL of the made-up disinfectant and 250 mL of the disinfectant concentrate. Contact the product manufacturer. Label each sample and forward to the laboratory with details of product (NRA registration number, product name, expiry date and batch number).

The estimated costs of confirmatory tests are: iodine concentration approximately \$50; HPLC testing for various analytes \$250 per sample minimum; and water quality panel of tests (cations x 8 by Inductively Coupled Plasma, organic matter, total dissolved solids, total plate count) approximately \$100.

If any problem is suspected with the purchased concentrate, it should be referred to the manufacturer immediately.

Independent laboratories with the capacity to test water / teat disinfectant active ingredients include:

**Australian Government Analytical Laboratories**

51-65 Clarke St, South Melbourne  
Victoria 3205  
Phone: (03) 9685 1777

**Australian Environmental Laboratories**

231 Burwood Rd, Hawthorn  
Victoria 3122  
Phone: (03) 9819 4326

**Monash Water Studies**

**Laboratory**

PO Box 23, Clayton  
Victoria 3168  
Phone: (03) 9905 4070

**Natural Resources and Environment Laboratory**

RMB 2460, Hazeldean Rd, Ellinbank,  
Victoria 3821  
Phone: (03) 5624 2258

**SGS Australia Environmental Laboratories**

PO Box 1956, Traralgon  
Victoria 3844  
Phone: (03) 5172 1555

**Water Ecoscience**

68 Ricketts Rd, Mount Waverley  
Victoria 3149  
Phone: (03) 9550 1000

*Details of other laboratories are available through the National Association of Testing Authorities website, [www.nata.asn.au](http://www.nata.asn.au)*

## 7.4 Ensure the dilution gives at least 0.5% iodine for iodophor products. Mix other products according to the label directions.

In Australia, all iodine-based teat disinfectants are registered for use at 0.5%.

During the past decade, overseas trial results have been used to promote use of lower concentrations. However, the results were not directly translatable to Australian dairy systems because they were based primarily on ready-to-use dip products (made up during manufacture with pure water). There is a real likelihood that teat disinfectants will fail if they are diluted to low concentrations with poor quality water.

Although 'very high quality' water is recommended, some farmers may have to use water that is not ideal. Some disinfectant will be neutralised in water that is hard, alkaline or contains organic material, especially in disinfectant preparations where more water is added (and more dilution occurs). Therefore, this guideline is a 'safety net' in the absence of clear directions about all water quality effects and comprehensive water testing on farm.

Until recently some labels were confusing and misleading. For example, many labels for iodophors stated that a greater dilution could be used when spraying compared with dipping, or that different iodophor concentrations could be used in different weather conditions. There was also a direction to wash all teats at the next milking. None of these recommendations had a basis in published data.

The National Registration Authority, in collaboration with industry has now taken leadership in providing guidelines on the clarity and consistency of labels. Under the new NRA guidelines, labels for iodophors and chlorhexidine concentrate products will have directions for use that specify:

- Ensure teats are clean and dry before milking to reduce organic and bacterial contaminations and iodine/chlorhexidine residue in milk. If washing is required for heavily soiled udder or teats, ensure they are properly dried.
- Thoroughly spray or dip all teats after every milking
- Mix fresh solutions daily. Do not top up solutions made up on previous day.
- To make a minimum of 0.5 % available iodine/chlorhexidine in the final solution dilute ..... part of ..... in ..... part ..... water (the quality of water must be specified)
- Emollient (the type of emollient must be specified e.g. food-grade glycerine) may be included to a maximum of 10%. If emollient is added, dilute..... part of ..... in ..... part of water and ..... part of emollient.
- Dip: Use a plastic or other non-metal type container for iodine solution. Clean out dip cup as teat dip gets low. Do not just top up the dip.
- Spray: Spray upwards from underneath the teats, not from the side and ensure the whole surface of each teat is covered.

Existing products are not required to change label designs, so old labels will still be seen for some time.

### Confidence – High

This guideline is a safety net given the absence of efficacy data to support the use of lower concentrations of iodophor products, the lack of clear directions about the effect of water quality on each product, and the variation in water quality on farms.

### Research priority – Low

See Technote 7.3 for methods of testing teat disinfectant mixes.

The correct way to mix teat disinfectant is described in Fact Sheet G of the *Countdown Downunder Farm Guidelines for Mastitis Control*. Advisers are encouraged to copy and distribute this to their clients.

Even with product labels that clearly state the required proportions of each component, the final mix of teat disinfectants used on farms will not be correct if the volumes are not measured accurately when mixing occurs. It is important that on each farm the steps for mixing teat disinfectant are clearly established and the task of mixing is allocated to staff who understand how to do it.

The availability of ready-to-use products in Australia now provides a new option for farms that experience difficulties in sourcing water of adequate quality or mixing solutions consistently. Many farms that wish to minimise the risk of having poor final mixes have changed to ready-to-use products.

If testing shows the concentration of available iodine in the final mix is less than 0.5%, check that:

- the mixing rate used on farm will achieve 0.5%;
- components are measured accurately;
- the type and amount of emollient used is appropriate;
- the water used is visibly free of organic matter and colloid;
- the water used is not alkaline (more than 500 parts per million  $\text{CaCO}_3$ );
- the stock product is within expiry date;
- the stock product is sealed and stored appropriately;
- the mix is made up freshly; and
- the container used to mix the teat disinfectant is clean.

## 7.5 Maintain teat condition – emollients (such as glycerine) may be added to improve teat skin condition.

An emollient is a compound used to soften or condition teat skin. The addition of emollients to teat disinfectant can improve teat skin health and so reduce the likely reservoir of mastitis pathogens in teat sores and cracks. They have an important role in mastitis control for these reasons.

Many teat disinfectants contain emollients when they are sold, especially those formulated with relatively low pH where skin irritation would be expected without some additional protectant.

Emollients registered for addition to specific teat disinfectants on farms (as distinct from emollients added to concentrates or ready-to-use products by manufacturers) can be found on the National Registration Authority website at [www.nra.gov.au](http://www.nra.gov.au).

Ideally, only emollients registered by the NRA for use on cows' teats would be used. However, products that are well regarded in the field, such as food-grade glycerine, are already available in the marketplace. It is therefore unlikely that they will be specifically registered and labelled for addition to teat disinfectants.

Bloat oil, canola oil or tea tree oil should not be used as emollients as they significantly reduce the efficiency of teat disinfectants (sometimes by 50% or more). 'White oils' (emulsified paraffin, bloat oil) are not recommended because they provide little benefit for teat skin condition (Brown 1984). In a series of half-udder experiments at Werribee in the 1970s, the condition of chapped teat skin failed to improve after more than eight weeks of treating with bloat oil, whereas there was a consistent and marked improvement in less than four weeks following applications of glycerol.

Addition of up to 9% glycerol led to improvement in teat skin condition when an iodophor dip was used in 30 dairy herds in the United Kingdom, but there was no further benefit at a concentration of 24% (Bramley 1981). The addition of 10% glycerol in the formulation of an iodine teat dip helped reduce *Staph aureus* colonisation and was associated with faster healing of teat chapping lesions (Fox et al 1991, Fox 1992). Skin condition in a Danish research herd milked robotically was significantly better when the teat spray contained 8% glycerol compared with 2% glycerol (Rasmussen et al 2002).

The addition of emollients can reduce the bactericidal activity of the disinfectant. The effect appears to differ with the concentration of the active ingredient. Australian research in the late 1970s (Sheldrake et al 1980) showed that a 0.5% iodine could contain emollient to 20%, but 0.1% iodine had reduced efficacy at 10% or more emollient.

The overall effect of the teat disinfectant preparation used is a balance between the bactericidal activity of the disinfectant component and the skin conditioning effect of the emollient. As a general summary of the published data, Countdown recommends not to exceed the label recommendation of 10% glycerol for regular use, as higher levels may interfere with the killing power of disinfectants.

When the Countdown Downunder Farm Guidelines were written in 1998, field

### Confidence – High

Maintenance of healthy skin condition is an extremely effective way to reduce bacterial populations on teat skin.

### Research priority – Low

It is possible that bactericidal efficacy of different disinfectants is affected by the type and concentration of different emollients.

Revised Technote 9 (February 2003) describes the evaluation of teats and teat lesions.

Glycerol is the name of the compound. Glycerine is the name of the product.

experience indicated that if teat condition was particularly bad (e.g. due to severe weather conditions or irritation following a change of teat disinfectant) glycerol concentration could be increased to 20%, but for not more than two weeks. In this situation, the advantages of improved skin conditioning were traded off against the possible reduction in bactericidal effect for a short period. This would now be considered an 'off label' preparation of a teat disinfectant product and would need to be used under veterinary prescription.

Field observations have shown that turbidity occurs if emollients exceed 12% of the final mix with chlorhexidine products (personal communication, Ecolab).

### Adding emollients

Many registered teat disinfectants are marketed with some emollient incorporated. More emollient may be added to bring the concentration in the final mix to a maximum of 10%.

Farmers often require guidance about the amount of emollient to add, given the concentration of emollient already in the product. An example calculation is shown below.

To ensure the disinfectant active ingredient remains at 0.5% in the final mix, calculate how much emollient to add and how much water to subtract.

Example calculation:

- A 100-cow herd requires 4 litres of made-up product daily to spray teats (100 cows x 2 milkings per day x 20 mL per cows per milking = 4,000 mL).
- Concentrate Product Y contains 20 g/litre iodine and 200 g/litre glycerol, labelled to mix in the ratio of 1 litre concentrate to 3 litres of water.  
When mixed according to label, the solution contains 200 g/4,000 mL = 5% of glycerol.
- To bring the emollient concentration to 10% in the final mix (400 g in 4,000 mL), add a further 200 gm (approximately 200 mL) of glycerol (bought as glycerine).
- Reduce the water by the volume of glycerine added – i.e. less 200 mL

Volumes in the final mix to achieve 4 litres with 10% emollient and 0.5% iodine:

1 litre concentrate Product Y  
200 mL glycerine  
2.8 litres water

## 7.6 Spray or dip the whole surface of *all teats* after every milking throughout lactation.

One of the biggest variables in successful use of teat disinfection is the quality and consistency of application. Failure to cover the whole teat of every cow at every milking is the most common error in teat disinfection.

Farmers who have attended Countdown Downunder Farmer Short Courses report that achieving good coverage of every teat at every milking is a major challenge. Performance is affected by factors involving operators and equipment. The 'people factors' include training for all operators on why and how to apply teat disinfectant, providing safe facilities to ensure operators can spray adequately, and arranging work routines to avoid boredom. The 'equipment factors' include choosing the approach (dip or spray) and the best appliance. Regular checking, cleaning and maintenance of equipment is also essential to getting consistently good coverage.

Disinfectant is applied by dipping each teat separately in a cup or by spraying disinfectant on to the teats from below. Dipping has the advantage that complete coverage of the teat barrel is fairly easy to achieve. Spraying disinfectant often coats one side of each teat only, and might use twice as much disinfectant in creating the aerosol and covering the base of udder (which is not the target area). Dipping avoids the potential of operators being exposed to aerosols, especially in windy conditions. Spraying is generally considered to be quicker and easier to incorporate into milking routines, although correct spray application may take as long as dipping. Spraying is the method of teat disinfectant application used in most Australian herds.

Because dipping provides more certain coverage of the whole surface of all teats, it is recommended in herds with particular mastitis problems. For example, some experienced advisers in the United States now insist that clients use teat dipping rather than spraying when attempting control of *Strep agalactiae*, especially in large herds. This requires an acclimatisation period of up to 2-3 weeks for cows that are unused to having their teats touched.

There is a vast array of products on the market that are designed to deliver disinfectant onto teats. Some delivery systems are discussed below.

### **Spraying**

Sprays can be applied using a gun-type hand piece with a spray nozzle or a fully automated spray system.

Teats should be sprayed from below using a circular motion to cover all sides of all teats. The coverage obtained from the different types of spray units and nozzles varies substantially. Spray nozzles that direct the spray vertically achieve far better teat coverage than horizontally directed jets (which are not satisfactory).

The poorest performing of all are the hand operated 'window cleaning' spray guns. It is difficult to reach the far sides of teats with this equipment, even with great effort, and operator fatigue occurs quickly. This type of equipment is not recommended. There is still a need for innovation in this area. For example, a more effective applicator could be a 'ring' spray, where the teat is surrounded by a ring with a number of jet holes spraying in and up rather than out and up.

### **Confidence – High**

Extensive field experience and experimental observations show that consistent application of post-milking teat disinfection is an essential element of mastitis control.

### **Research priority – High**

More efficient methods of dispensing teat disinfectants (e.g. better spray nozzles and automatic spray units) are required to improve teat skin coverage and minimise labour.

Despite the common saying that 'it is the drip at the end of the teat that's important', coverage is not considered adequate unless there is disinfectant on the whole surface of the teat.

Technote 7.7 gives tips on checking operator technique.

Nozzle openings can become blocked or corroded. Nozzles that don't produce the desired pattern or delivery rate should be serviced or changed.

See the Countdown Downunder Farm Guidelines for Mastitis Control page 39 for example of a 'hollow' spray pattern that is unsatisfactory.

Spray nozzles must allow the free passage of disinfectant and be checked regularly to ensure they achieve the spray pattern required. Spray nozzles should achieve an even cover of fine droplets that spread to about 10 centimetres diameter when spraying vertically upwards onto paper over a distance of 10 centimetres. Droplets should not be so fine that there is drift away from the target area.

Delivery of solution to hand-held spray units may be from:

- Manually operated pressurised sprayers with reservoirs which last for a hundred or so cows without the need to refill (2,000 mL); or
- Semi-automatic application systems where disinfectant solution is delivered via a pressurised line into the milking area from a reservoir normally outside in the machine or vat room. With these installations there is normally one wand applicator for a number of milking units, suspended from the ceiling.

Fully automated teat disinfectant delivery systems are also available. Most commonly they are used at the exit of rotary milking platforms, or are installed just after the exit in a dedicated teat spray lane. Infrared light beams activate spray nozzles and spray patterns are adjusted to the average cow's udder. Under current practical conditions, good coverage for all teats is very difficult to achieve. They also require more disinfectant solution, some of which is poorly directed.

### ***Dipping***

Dips can be applied by hand-held cups or with a 'power dipper' (a dip cup on a wand with solution applied when a trigger is activated) .

Teat dip cups are hand-held and usually 200-400 mL in size. They sometimes come with a small bottle below the cup from which disinfectant is squeezed through a one-way valve. The act of immersing each teat in a reservoir of disinfectant usually ensures that the entire teat barrel (any area in contact with the teat liner) will be covered, as long as the cup is deep enough and filled with the appropriate amount of effective solution.

Cups should be emptied before refilling, rather than 'topped up' when the solution becomes low. This application method requires slightly more time than most spraying applications when taking preparation, refilling and actual application into account.

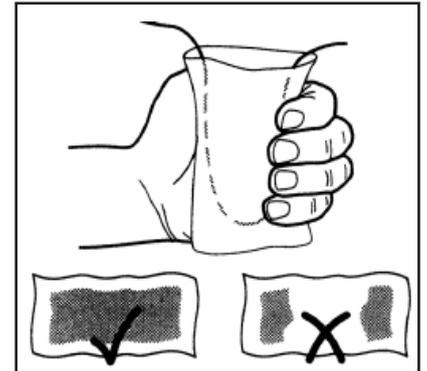
'Power dippers' are used in a few dairies in Australia, but do not appear to fully cover the barrel of larger teats.

## 7.7 Check operator technique.

Careful operators can achieve very good results with teat spraying. However, errors are much more easily made when spraying compared to dipping. Farmers at the Countdown Farmer Short Courses have included many changes in their mastitis and milk quality action plans to improve operator technique. Encouraging milking staff to regularly assess their own and each other's teat coverage is important.

Simple checks include:

- Examining individual teats of several cows to determine if all sides of the teat barrel are being covered. Wrapping a paper towel around the barrel, then carefully removing and examining the wet or stained area can assist this procedure.
- Checking that at least 20 mL of prepared teat disinfectant is being used per cow per milking if spraying (or 10 mL if dipping). This involves measuring the total amount of teat disinfectant used over two milkings, and dividing this number by the total number of cows milked at both milkings.
- Checking the time in seconds that is needed to apply the correct amount of disinfectant solution. This can be done, for example, by counting the number of seconds required to fill an empty 20 mL syringe barrel with the spray. This can then be compared with the actual time that operators take to spray each cow.



**Checking coverage with a paper towel**

(used with permission from Daviesway)

Regular review of teat disinfection efficiency with an adviser can also add to staff training and awareness about the importance of this routine activity in mastitis control.

## Part of a farm mastitis action plan

My teat disinfection					
Farm	What to change	Who's involved		By when	Done
		On-farm	Off-farm (Vets)		
Guideline					
△	Add another spray gun back around platform & change nozzles	†	Bill	8 Aug	<input checked="" type="checkbox"/>
△	Check with paper towels every month	†	Jamian Diane	Aug ✓ Sept Oct	<input type="checkbox"/>
△	Talk to vet about milker - full spray	†	Diane	end Aug	<input type="checkbox"/>
△	Get dip and water checked	†	Bill Peter	end Aug	<input checked="" type="checkbox"/>
△	Re-do milking instructions - specific night		Jamian	8 Aug	<input type="checkbox"/>
△	Have Peter cover teats		Bill Peter	end Sept	<input type="checkbox"/>

## 7.8 When dipping, clean out dip cup as teat dip gets low – don't just top up the dip.

It is important to minimise the amount of milk or other organic material in the dip cup as this:

- reduces the efficacy of teat disinfectants; and
  - may become a mechanism for transmitting bacterial infections between cows.
- Only a small amount of contamination with milk film (the most likely cause of soiling of teat disinfectants applied by dipping) occurs in most dip cups.

Disposal of waste teat disinfectant should be considered in farm plans for safe disposal of all expired or spent chemicals. In some regions local authorities provide a service to remove industrial waste chemicals.

### Key papers

- Bramley AJ. The role of hygiene in preventing intramammary infection. In: Mastitis Control and Herd Management, Technical Bulletin 4. National Institute for Research in Dairying, Reading, England, 1981:53-65
- Bramley AJ. Mastitis and machine milking. In: Bramley AJ, Dodd FH, Mein GA, Bramley JA editors. Machine milking and lactation, Chapter 10. Insight Books, Vermont, United States, 1992:343-372.
- Bramley AJ, Kingwell RG, Griffin TK, Simpkin L. Prevalence of *Corynebacterium bovis* in bovine milk samples. *Vet Rec* 1976;99:275.
- Brown M. Post milking udder hygiene – teat disinfection. In: Machine milking and mastitis, Seminar for Veterinarians, The University of Melbourne Veterinary School, June, 1984.
- Denton GW. Chlorhexidine. In: Block SS editor Disinfection, sterilization, and preservation 5th edition, Chapter 15. Lippincott, Williams and Wilkins, Philadelphia (US). 2001: 321-336.
- Dychdala GR, Lopes JA. Surface-active agents: acid-anionic compounds. In: Block SS editor Disinfection, sterilization, and preservation 4th edition, Chapter 14. Lea & Febiger, Philadelphia (US). 1991: 256-262.
- Fox LK, Nagy JA, Hillers JK, Cronrath JD, Ratkowsky DA. Effects of postmilking teat treatment on the colonization of *Staphylococcus aureus* on chapped teat skin. *Am J Vet Res* 1991;52:799-802.
- Fox LK. Colonization by *Staphylococcus aureus* on chapped teat skin: effect of iodine and chlorhexidine postmilking disinfectants. *J Dairy Sci* 1992;75:66-71.
- Hillerton JE. Control of mastitis. In: Phillips CJC, editor. Progress in Dairy Science, CAB International. 1997;171-191.
- Lee PW. Teat disinfection usage by north eastern Victorian dairy farmers, Dissertation for the Master of Veterinary Studies, University of Melbourne, 1994.
- National Mastitis Council Laboratory Handbook on Bovine Mastitis Madison, Wisconsin (US) Revised Edition, 1999, p135.
- National Mastitis Council. Summary of peer-reviewed publications on efficacy of pre-milking and postmilking teat disinfectants published since 1980, updated January 2001. NMC website [nmconline.org](http://nmconline.org)
- Rasmussen MD, Hemling TC. The influence of automatic teat spraying on teat condition. In: Proceedings 41st Annual Meeting, National Mastitis Council, Orlando, Florida. 2002:166-167.
- Ryan D. Investigation of mastitis problem farms. In: Post Graduate Foundation in Veterinary Science Proceedings 161, Dairy medicine and production, University of Sydney, 1991:43-58.
- Sheldrake RF, Hoare RJT, Hutchinson JE. Post-milking iodine teat skin disinfectants: 1. Bactericidal efficacy. *J Dairy Res* 1980;47:19-26.
- Tattawasart U, Maillard JY, Furr JR, Russell A D. Development of resistance to chlorhexadine diacetate and cetylpyridinium chloride in *Pseudomonas stutzeri* and changes in antibiotic susceptibility. *Journal of Hospital Infection* 1999;42(3)219-229.
- Woolford M. Teat-spray to halve mastitis. *Dairy Exporter* 2001; September: 23.