

Manage teat sores and cracks

The physical condition of the bovine teat is an indicator of the quality of the environment, the milking management and milking system used on a dairy herd, and can also be used as an indicator for the risk of intramammary infections.

Mastitis risk is a numbers game – greater numbers of bacteria near the teat end increase the risk of infections occurring. Teat sores and cracks provide sites where bacteria can multiply. They can be painful to the cow, causing her to kick and defecate more frequently during milking time, and have poor let-down.

Healthy skin is easier to keep clean.

Defence mechanisms of the teat canal

Mastitis occurs when bacteria enter the mammary gland via the teat canal. There are four physical mechanisms of the teat end and teat canal that protect against bacterial invasion. These are:

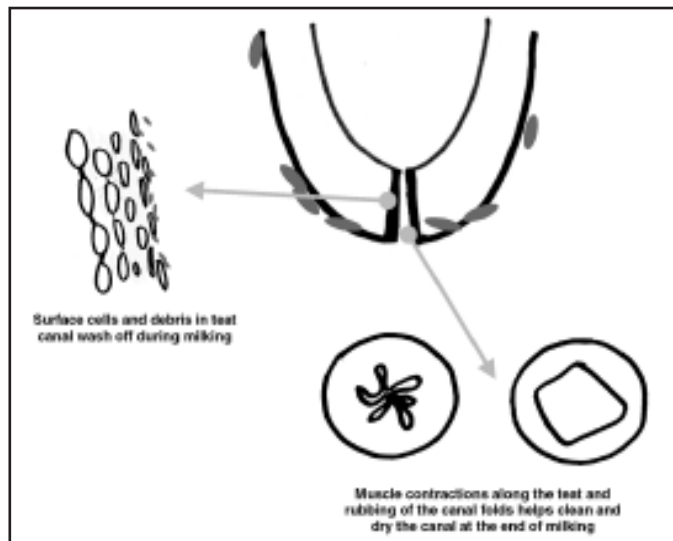
- tight closure and effective sealing of the teat canal between milkings;
- adherence of bacteria to the keratin lining of the teat canal;
- shearing of the keratin lining during milk flow; and
- drying and re-sealing of the canal lumen during the early post-milking period.

Disruptions to any of these increase the susceptibility of the udder to infection.

The teat canal is lined by a modified skin layer (epithelium) that is continuous with the outer teat skin. Typically, the canal is about 10-12 millimetres long. When opened, the circumference of the milk contact surface is about 6 millimetres. When closed in the inter-milking period, the canal is folded.

Keratin is a waxy substance produced by the cells lining the teat canal. It serves as a temporary seal between milkings and a more permanent plug throughout the dry period. Keratin is also a major structural component in skin, hair, nails and hoof cells.

Defence mechanisms of the teat end



The teat canal provides the first and most important barrier to bacteria entering the udder. The new infection risk is increased if:

- The effective diameter of the teat canal is relatively wide (as indicated by higher peak milking rate from the teat). For example, teats with wider canals had higher infection rates in the dry period (Dodd and Neave 1951), and similarly in experiments involving artificially high bacterial challenge during lactation (Grindal and Hillerton 1991).
- The teat canal is shorter than average (Lacy-Hulbert 1998).
- The keratin that fills the lumen of the teat canal does not seal the canal effectively in the inter-milking period or during the dry period. For example, incomplete sealing of the keratin plug was linked with higher new infection rate in the dry period (Williamson et al 1995). During lactation, high bacterial challenges led to higher infection rates if keratin was removed from the teat canal by reaming (Capuco et al 1992).

Technote 14 describes the importance of the keratin plug in the teat canal at drying-off.

The defence mechanisms that resist bacterial penetration through the teat canal are primarily physical in action (Williams 1984, Williams and Mein 1985, Lacy-Hulbert 1998). At a microscopic level they involve:

- formation of a lipid film in mature keratin layers that allows easy opening and cleaning of the teat canal during milking or suckling; and
- effective re-sealing of the canal when milking or suckling ceases.

Mature keratin cells are held loosely together in this film of lipid and bacteria in the canal stick to these cells. During milking, the action of pulsation and the flow of milk through the teat canal wash away a high proportion of the mature keratin cells and any adherent bacteria. This flushing action has the effect of cleaning the teat canal surface. The lipid film is continuously replenished by the keratin cells lining the canal.

For the teat canal to effectively seal at the end of milking it must have a clean surface, free of cell debris and milk. When the teatcups are removed, waves of muscle contraction occur in the teat. The film of milk on the teat canal surface is disrupted by the 'wringing' action of this muscle contraction (passing from the base of the teat to its apex) and squeezing between the folds of the teat canal

lining. The absence of a continuous column of milk within the canal prevents movement of bacteria by capillary action along the canal and stops their migration from the teat orifice to the udder cistern. The external teat orifice is then dried by ambient air assisting this natural defence mechanism.

These physical mechanisms operating within the teat canal have many practical and interesting consequences. For example:

- The milk stream associated with normal milking vacuum levels (about seven metres per second in the initial pulsation cycle of a correctly functioning machine) provides sufficient force to clean the lining of the teat canal by shearing the outermost layer of mature keratin cells, removing debris in the canal.
- Pulsation causes an action in the teat canal analogous to cleaning hands by rubbing them together under a tap. A cyclical pressure, applied by the liner collapsing around the teat apex at regular intervals, physically loosens debris that is flushed away during the next pulsation cycle. Capuco et al (1994) found nearly 40% of the mature keratin cells were removed at every milking by the combined effects of milk flow and pulsation compared with an average loss of about 25% in the absence of pulsation.
- The ability of the teat canal to trap bacteria is markedly reduced if the teat lining is not flushed clean by the end of milking. Milking without pulsation in post-milking challenge experiments leads to very high new infection rates. A possible explanation for this is that the lining of the teat canal is still dirty (with mature keratin cells and surface debris) at the end of milking.
- Up to five million non-specific bacteria-sized particles (including bacteria) can adhere to the surface of an average-size teat canal before it becomes overloaded. Overloading can occur when teats are challenged with high environmental loads – for instance dried manure bedding in barns in conditions of high humidity can contribute 10-100 million colony-forming units per milligram of *Escherichia coli*.
- Bacteria cannot move towards the udder cistern if only small, isolated spots of milk remain on the teat canal lining after it has been 'wrung dry'. Bacteria, however, are often found in these 'lakes' and species such as *Strep agalactiae*, *Staph aureus* and *Corynebacterium bovis* are capable of using teat canal lipid as a sole energy source to grow and divide.

An implication of natural defence mechanisms is that reduced rates of new mastitis infections associated with more frequent milking are linked with more regular flushing and cleaning of the teat canal.

Conversely, one of the main reasons for a higher infection risk in the early dry period is the absence of a mechanism for regular removal of pathogens adhering to the surface cells of the teat canals.

Confidence – High

Maintenance of healthy teat skin is a key requirement for an effective mastitis program.

Research priority – Moderate

International agreement on teat evaluation methods was achieved in September 2001. Further analyses are required to refine current guidelines for interpretation of results. These include:

- thresholds of concern for different teat conditions; and
- the significance of 'No Ring' versus 'Smooth Ring' for teat end scoring.

Revised Technote 13 (February 2003) contains a Mastitis Investigation Pack with a recording sheet for teat condition (Sheet I).

9.1 Assess teat skin and teat ends every milking.

Changes to teat tissue, particularly the skin of the barrel, teat end and teat canal, will alter udder defence systems. Veterinarians, field extension personnel, and farmers require a simple and reliable method for evaluating teat health in dairy herds. For farmers and advisers investigating possible problems identified by general observation of teats, it is important to have a method of qualitatively or quantitatively recording teat condition on a representative number of cows at standard milkings (Morgan 1999).

A protocol for systematic evaluation of teat condition in commercial herds, together with guidelines for interpretation of observations, has been developed by an informal discussion group of researchers and udder health advisers self-styled as the 'Teat Club International' (Mein et al 2001) and forms the basis of this Technote.

Various agents and mechanisms may affect the condition of the teats of the milking dairy cow. In general, these fall into one of three broad categories:

- milking-induced (machines and management);
- environmental; and
- infectious.

The table below lists the main conditions in the first two categories. For infectious conditions, see page 10.

Teat conditions arising from milking-induced and environmental effects in Australia

Milking-induced	Environmental
Discolouration	Skin dryness or roughness
Firmness or swelling	Hyperkeratosis
Wedging of the teat end	Chapping
Openness of the teat orifice	Abrasions and cuts
Petechial haemorrhages	Photosensitization
Hyperkeratosis (thickening of the skin)	Chemical damage
	Allergic reactions
	Fly bites

Milking-induced or environmental changes

The relative influence of milking-induced or environmental factors affecting short-, medium- or longer-term changes in teat condition are reviewed briefly and discussed in this section.

Observations associated with short-term changes in teat condition

Short-term changes are generally regarded as those seen in response to a single milking. Faults in milking machines or milking management are the primary cause of short-term effects such as changes in colour, firmness or swelling at the teat end or teat barrel, the degree of openness of the teat end and sensitivity to touch. Countdown no longer recommends systematic assessment of sensitivity to touch because it is too difficult to assess, especially in herds where cows are not used to having their teats touched.

Colour changes

Some teats are noticeably red, either at the teat end or over the entire teat, when the cluster is removed. Others may become reddened within 30-60 seconds of cluster removal. In extreme cases, teats become blue or already appear blue when the cluster is removed. Poor teat colour after milking may be worse for short or slender teats because they are supported less effectively by the liner.

Reddish discolouration, indicating congestion, is exacerbated by over milking, (especially with wide-bore liners or tapered liners with wide upper barrels); unusually heavy cluster weight; high milking vacuum; faulty pulsation; or mismatch between the type of liner used and mean teat size within a herd. Bluish discolouration, indicating cyanosis, may result from use of liners with small mouthpiece diameter relative to the internal diameter of the barrel or liners mounted at unusually high tension.

Although they are still subject to the same damaging influences, black teats and most pigmented teats must be excluded from any colour-based evaluation because these changes cannot be seen.

Colour changes are classified according to the proportion of light-coloured teats which, when examined within one minute of cluster removal, are:

- Normal – pink.
- Red – part of or all the teat may be reddened.
- Blue – part of or all the teat appears to be tinged with blue or purple.

Because the causes of reddened or bluish teats may differ, red and blue classes should be recorded separately. However, analysis is simplified by combining these two changes into a single category 'Red or Blue'.

Swelling at or near the teat base

When examined after milking, the upper part of the teat may have a visible line or mark caused by contact with the liner mouthpiece lip, or visible swelling with a palpable, thickened ring. This occurs in the unsupported part of the teat that was inside the liner mouthpiece chamber near the end of milking. To avoid confusion with physiological swelling of teats and udders, cows with obvious signs of udder oedema or cows that calved within one week should not be evaluated.

Factors commonly responsible for swelling around the top of the teat as a direct

Teat cup crawling occurs when a teat cup moves so far up the teat that the passage of milk from the udder to the teat is obstructed.

result of milking include: high mouthpiece vacuum associated with wide-bore liners; over-milking, especially with wide-bore liners or tapered liners with wide upper barrels; liners with a large mouthpiece chamber; teatcup crawling; or liner mouthpiece lips that are unusually stiff or narrow in relation to teat size.

Swelling at or near the teat base when examined within one minute of cluster removal are classed as:

- Normal – no ring, little or no swelling, and teats that have a visible mouthpiece lip mark or ‘garter mark’ (Hillerton et al 2000).
- Swollen – if there is marked swelling or palpable thickened ring.

Firmness at or near the teat end

Many teats feel soft and pliant after milking and they contract when touched. However, some teats feel swollen or firm or, in extreme cases, hard and unresponsive to touch. Factors commonly responsible for swelling near the teat end include: over-milking; use of wide-bore liners; high vacuum; pulsation failure; or insufficient rest phase of pulsation.

Teats may look flat or wedge-shaped after milking. ‘Wedging’ describes the flattened shape of the teat end due to the compressive load applied by the opposing walls of a collapsed liner. Typically, this wedging will be slight. Severe wedging may result from: hard liners; liners mounted under high tension; a prolonged D-phase; or failure of the liners to open fully.

Teat ends are classified, by simple visual examination supported by manual palpation, as:

- Normal – soft and supple.
- Firm – firm, swollen or hard, or noticeably wedged.

Openness of the teat orifice

When examined immediately after milking, the external teat orifice may appear to be closed, slightly open or, in extreme cases, has a funnel-shaped opening about the size of a match-head. According to unpublished observations (cited in Mein et al 2001), both the new infection rate and the proportion of teats with open teat orifices were reduced in several mastitis problem herds in Australia, United Kingdom and United States following changes to milking equipment or procedures. In most of these anecdotal reports, a change in liner type was thought to be the main contributing factor in solving the mastitis problem.

Factors linked with short-term, post-milking openness of the teat orifice include high milking vacuum, over-milking, unusually heavy cluster weight, or high liner mounting tension.

Teat orifices are classified by qualitative assessment within one minute of cluster removal as:

- Closed.
- Open – more than 2 millimetres wide or deep.

When estimating the degree of openness, it may be helpful to mentally compare the width and depth of an open orifice with that of a common object such as a

match-head (typically about 3 millimetres in diameter) or the shaft of the match (about 2 millimetres). A clean paper towel may be needed to remove milk residue from the teat end to facilitate assessment.

Observations associated with medium-term or longer-term changes in teat condition

Medium-term changes in teat condition refer to tissue responses that take a few days or weeks to become visible, and often manifest as vascular damage or changes in teat skin or teat end condition.

Machine-induced haemorrhages of the teat skin (petechial or larger haemorrhages) may take several days to become evident.

Changes in teat skin condition associated with harsh weather or chemical irritation may take a few days or weeks to become visible. It typically takes 2-8 weeks for thickening of the skin (hyperkeratosis) at the teat end to develop. However, seasonal conditions can affect the dryness and hardness of keratin and teat ends of individual cows or herds are able to change within days, especially in regions subject to harsh weather conditions or sudden weather changes.

Skin condition

Healthy teat skin is coated with a protective mantle of fatty acids that slow the growth of bacterial pathogens.

In cold, wet and windy conditions, the skin of machine-milked teats often becomes scaly, irritated or chapped (broken) and the protective surface coating may be removed – allowing colonisation of pathogens such as *Staph aureus*. Cold, wet or muddy conditions also induce hardening or thickening of teat skin. Mud, as it dries, draws moisture from the skin with a consequent loss of elasticity of the teat skin. Machine milking exacerbates problems of chapping or cracking.

Chemical irritation associated with disinfectant type or concentration, or inappropriate type or concentration of emollients, may exacerbate the effects of harsh weather conditions and promote teat chapping. Skin conditioners or emollients either reduce evaporation from the skin or act as humectants (moisturisers) to maintain or improve the teat skin condition.

In the absence of cracks and sores, there is no distinguishable difference between dry and normal teat skin on new mastitis infection rates (Rasmussen and Larsen 1998). Teat skin condition is classified as:

- Normal – smooth sheen, soft, healthy skin.
- Dry – scaly, flaky or rough skin but with no cracking.
- Lesion – if there is any infectious or open lesion on the barrel or teat end, including chapped or cracked skin, and blackspot.

Vascular damage (haemorrhage)

The proportion of teats with evidence of petechial haemorrhages (or more extensive haemorrhaging) on their teats gives an indication of the presence and

The dryness of black teats tends to be over-estimated by observation alone. Evaluation is improved by lightly rubbing the teat skin with a finger.

extent of vascular damage. Vascular damage usually reflects some type of pulsation failure often associated with high vacuum and/or prolonged over-milking. The incidence of vascular damage is lower in herds milked with narrow-bore liners, at low vacuum, and/or with automatic cluster removers.

Teat end hyperkeratosis

Teat end hyperkeratosis is a thickening of the skin of the teat end (giving roughness, cornification or callus formation). It is a dynamic condition.

Skin thickens in response to the forces applied to it. Just as the skin on a person's hands thickens in response to outdoor, manual work, so the skin of the teat end thickens in response to milking and environmental effects. All teats experience low milk flow periods at the beginning and end of each milking and teat end condition deteriorates when flow is less than one litre per minute. More hyperkeratosis occurs with increased total time per day below this milk flow rate.

The major factors affecting teat end hyperkeratosis are seasonal weather conditions, and milking management and machine factors (see table below).

Teat end hyperkeratosis may be exacerbated by disinfectants that cause chemical irritation to teat skin or may be improved by the use of a disinfectant with a high concentration of an effective emollient.



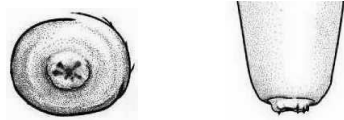
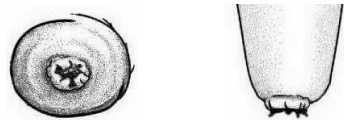
The Teat Club International notes that a small amount of teat end hyperkeratosis may be considered as a beneficial physiological response of the teat to machine milking whereas a greater degree of roughness is associated with an increased probability of new intramammary infections (Neijenhuis et al 2001).

Major risk factors affecting teat end hyperkeratosis

Risk factor	Reason for increased likelihood of teat end hyperkeratosis
Pointed teats	The load applied by the closing liner is on a smaller area of teat surface
Increasing age	The 'wrinkle factor' in all species
Higher production	Cups are on for longer
Peak lactation	Cups are on for longer
Udder washing	Water and chemicals reduce skin moisture and elasticity
Cups on before let down	Longer period of milk flow below one litre per minute
Low thresholds for Automatic Cluster Removers (ACRs)	Longer period of milk flow below one litre per minute
Over-milking	Longer period of milk flow below one litre per minute
High vacuum	Greater stress on teat tissues – more stretched in the open liner and squeezed in the closer liner
Stiff liner mouthpiece	The lip acts like a tourniquet which slows or restricts outflow of blood from the teat wall when the liner is collapsed
Liners mounted at high tension	The region of greatest local pressure is applied just above rather than at the teat end. This restricts outflow of blood from the teat tip (acts like squeezing a grape until the skin splits)

For routine field evaluation (in contrast to more detailed research observations), teat ends are scored as shown below.

A scoring system for teat end hyperkeratosis (Mein *et al* 2001)

Score	Description	Illustration
N	<p>No ring</p> <p>The teat end is smooth with a small, even orifice. This is a typical status for many teats soon after the start of lactation.</p>	
S	<p>Smooth or Slightly rough ring</p> <p>A raised ring encircles the orifice. The surface of the ring is smooth or it may feel slightly rough, but no fronds of old keratin are evident.</p>	
R	<p>Rough ring</p> <p>A raised, roughened ring with isolated fronds or mounds of old keratin extending 1-3 mm from the orifice.</p>	
V	<p>Very rough ring</p> <p>A raised ring with rough fronds or mounds of old keratin extending 4 mm or more from the orifice. The rim of the ring is rough and cracked, often giving the teat end a 'flowered' appearance.</p>	

The teat end scoring system (0-4) previously used by Countdown has been replaced by this category system, in line with international use.

- The 'N' category includes teat ends previously scored as 1 in Australia.
- The 'S' category includes teat ends previously scored as 1 in Australia.
- The 'R' category, which indicates some breakdown in epithelial integrity, includes teat ends previously scored as 2 in Australia.
- The 'V' category includes teat ends previously scored as 3 in Australia.
- Teat ends with lesions, previously scored as 4 in Australia, are now recorded as skin condition (in column 1 of Sheet I in revised Technote 13, February 2003).

See the Countdown website – www.countdown.org.au – for images of teat conditions.

Teat conditions due to infectious agents

Infectious lesions of teat skin can indicate the standard of the general hygiene practices as well as mastitis prevention and milk quality management employed on the farm. Any deterioration of teat skin condition may adversely influence milk quality, milk safety, and udder health. Some may be hazardous to the health and safety of staff.

Viruses, pus-forming or necrotizing bacteria, and fungi are responsible for most infectious lesions of teat skin and can affect the skin of the teat end, teat barrel or udder.

Viral infections of teat skin

Viral infections vary in their severity, infectivity and frequency of occurrence. Generally, they are rare in dairy industries where good udder hygiene is applied because most are readily controlled by minimising transmission via manual handling and also by use of post-milking teat disinfection.

Teat disinfection helps prevent viral infections even though most are not strong or specific enough to remove viruses. Many viruses require breaks in the skin to start infections. Application of post-milking disinfectants and emollients reduces the incidence of sores, rough skin, and cracks necessary for viral penetration and development.

Some exotic diseases cause lesions on teats (Geering et al 1995).

Viral infections of the teat

Viral infection	More information	Typical lesion
Pseudocowpox	'Pseudocowpox' FAQ sheet	Looking like a herpes lesion, it develops as a plaque into small, raised, circumscribed lesions with dark red centres. A characteristic ring or 'horseshoe' shaped scab may be seen when crusts fall away. People are occasionally infected with purple 'milkers' nodules on their fingers.
Bovine herpes mamillitis	'Bovine herpes mamillitis' FAQ sheet	Numerous, raised, oedematous plaques about 1-2 centimetres in size. Lesions can cover a large part of the teat surface. The skin sloughs off leaving raw ulcers that are subsequently covered with dark coloured scabs.
Teat warts – papilloma	'Teat wart' FAQ sheet	Appearance varies with strain of virus from 'rice grain' in appearance, to fronds.
Foot and mouth disease (exotic)		Occasionally, the virus causes vesicular lesions and erosions on teats before they appear in the mouth.
Vesicular stomatitis (exotic)		Lesions on the teat are similar to those of foot and mouth disease.

Bacterial infections of teat skin

Bacteria may cause primary lesions or colonise the sites of existing lesions arising from machine-induced damage, environmental factors or viral infections.

Staph aureus, Strep dysgalactiae and Arcanobacterium pyogenes are ubiquitous on the skin of dairy cows. These bacterial infections of teat skin are a major source of new intramammary infections and clinical mastitis, both in lactating and non-lactating cows. It was shown clearly some 30 years ago that chapped teats were highly likely to be infected with Staph aureus or Strep dysgalactiae, and that such infections were closely associated with high new infection rates and frequent cases of clinical mastitis (Kingwill et al 1970).

Disinfectants developed for teat treatment are usually effective at eliminating bacteria from lesions and often contain emollients to promote skin healing. The requirement to disinfect all teats of all cows after every milking, as part of mastitis control, is directed at reducing the exposure of the mammary gland to these organisms and to expedite rapid healing of all lesions.

One particularly important bacterial lesion, often associated with poor machine milking, is colonisation of the damaged teat orifice by Fusiformis necrophorum. This condition is known as blackspot and is easily recognisable from the colour of the scab formed. Bacteria erode the teat end and the orifice may become blocked, leading to incomplete and very slow milking. Blackspot is a major risk factor to intramammary infection by other bacteria.

Revised Technote 7 (February 2003) describes the characteristics of effective teat disinfectants and emollients.

Bacterial infections of the teat

Bacterial infection	More information	Typical lesion
Staph aureus, Strep dysgalactiae, A. pyogenes		Primary bacterial infections present as pustules. They may be necrotising, especially when Staph aureus is involved. Secondary bacterial infections may cause significant changes in the appearance of other lesions, making diagnosis difficult.
Blackspot – Fusiformis necrophorum	Blackspot FAQ Sheet	Lesions look like craters with raised edges and have a black spot of ulceration or scab in the centre. They often involve the teat end.

Fungal infections of the teat skin

Infection of skin keratin by the fungus Trichophyton spp. occasionally spreads to the teat. The condition is very unlikely to be confined to the teats and udder and should be easily recognised from the characteristic grey-white and ash-like skin encrustations.

The infection is highly contagious and may spread to milking staff. Usually herd immunity develops but reoccurrence is typical when new susceptible animals are introduced or animals are immune-stressed, especially as spores survive in the environment for several years.

Fungal infections of the teat

Bacterial infection	More information	Typical lesion
Ringworm – Trichophyton spp.		A characteristic grey-white encrustation. The infection may spread to milking staff.

Revised Technote 13 (February 2003) contains a Mastitis Investigation Pack with a recording sheet for teat condition (Sheet I).

Systematic evaluation of teat condition in commercial herds

Deciding how many teats to observe

Perhaps the most common weakness of teat evaluation procedures in commercial herds is that sample sizes are too small (Reinemann et al 2001).

A guide to initial sample size is:

- In herds of up to 500 cows, assess all teats on at least 25 randomly selected cows, or 10% of the herd, whichever is the greatest.
- In herds of more than 500 cows, assess all teats on at least 50 randomly selected cows.

Sampling more cows will increase the accuracy of the diagnosis.

Making the observations

To simplify and streamline the procedure, teat condition should be evaluated immediately after the cluster is removed and before application of a teat disinfectant. However, if an observer wants or needs to assess skin changes in greater detail, it will be necessary to check skin condition before milking.

Practical tips to making teat observations are:

- Exercise great care when approaching cows and handling teats – especially in herds where cows are not used to having their teats touched.
- Observe and record teats in a regular pattern.
- View the teats, initially, without handling.
- Dry the teat end with a paper towel if milk residue or debris obscures the view of the orifice.
- View teats by gently grasping the teat above the teat end. Observe the teat from side on and then from end on. Good lighting is essential. If lighting is poor, use a headlamp rather than a flashlight for hands-free evaluation. This is important for increased work safety.
- To ensure confidence in the data, score a representative sample of cows from all age groups or management groups.
- An automatic recording method, such as a dictaphone with a 'pause' button, enables a single observer to evaluate and record teats. (Note a voice-activated recorder is difficult to use successfully in the noisy environment of the farm dairy.) If two people are present, one can observe teats while the other records data.
- A digital camera offers an excellent way to capture typical or interesting teat conditions for subsequent discussions with the farmer or other udder health specialists (or lawyers!).

Interpreting the results

Countdown is currently collecting Australian data to define the threshold levels of abnormalities for herds with teat condition problems. As an interim guide, further investigations of milking machine, management, environmental and infectious factors may be required if one or more of the following are observed:

- Colour: more than 20% of light-coloured teats that are visibly reddened (congested) or tinged with blue (cyanotic).
- Swelling at or near the top of the teat: more than 20% of teats have marked swelling or palpable rings.
- Firmness at or near the teat end: more than 20% of teats ends are classified as firm, hard or swollen, or noticeably wedged.
- Openness of teat orifice: more than 20% of teat orifices are classed as open.
- Vascular damage: more than 10% of light-coloured teats have petechiations.
- Teat skin condition: more than 5% of teats have open lesions (including chaps or cracks).
- Teat end hyperkeratosis: more than 20% of teats are scored R or V, or more than 10% scored V.

It is important to use the proportion of abnormalities observed in a sample of teats from the herd as a guide rather than an inflexible threshold. Some herds that do have teat abnormalities may have values slightly below the threshold because:

- the sample of teats observed was not representative of the herd; or
- the estimate generated by the sample is within the lower limit of the 95% confidence interval for the threshold value (illustrated in the table below).

In this situation, it is worthwhile examining more teats before making a final assessment of the situation – especially if additional problems (with the milking machine, milking system or other teat abnormalities) have been identified in the herd.

Colour, swelling near the top of the teat, firmness near the teat end, openness of teat orifice and vascular damage are short to medium-term effects primarily associated with milking machine faults or poor milking management resulting in long periods of low flow below 1 litre/minute and/or over milking.

Teat skin condition and teat end hyperkeratosis are medium to longer-term effects primarily associated with poor environment, management or chemical irritation, or cow factors such as teat shape, yield and genetics. They are exacerbated by machine milking, especially if poor milking management results in over milking or prolonged milking at a low milk flow rate. Faults in milking equipment are unlikely to be primary causal factors if one or more of the short-term changes are not obvious.

Using a sample to detect when the prevalence of teat abnormalities in herds is likely to be 10% or 20% (based on the binomial distribution)

If you observe ... teats	And more than ... have the abnormality	Then suspect at least ...% of teats in the herd have the abnormality*
100	5	10
100	13	20
200	13	10
200	30	20
300	21	10
300	47	20
400	29	10
400	65	20

*The values in the second column show the lower limit of the 95% confidence interval for the herd proportion. For these figures to be valid, teats must be randomly selected from the herd and independent (when an abnormality is observed on one teat, other teats on the same udders should be no more or less likely to be affected).

The primary focus of observation is on teats (rather than cows) because this is the easiest way to make an initial assessment of whether or not a problem exists within a herd. Therefore the first analysis is the proportion of teats affected with a particular condition.

Clearly this initial assessment may require some qualification. For example, a high proportion of cows may have the same teat affected. Alternatively, only a few cows may contribute most of the 'problem' teats if they each have 3-4 teats affected. These types of patterns can be very helpful indicators of a milking machine problem or a cow problem.

Some of the common primary causes or exacerbating influences for particular teat conditions are listed in the table below.

Some of the common primary causes or exacerbating influences on teat condition

	Skin condition		Colour		Swelling at base	Firmness		Open orifice	Teat end hyperkeratosis
	Lesions	Haems	Red	Blue		teat end	Wedging		
Machine factors									
High vacuum									
Faulty pulsation									
Short D-phase									
Long D-phase									
Wide bore liners*									
Large mouthpiece chamber*									
Small mouthpiece lip diameter*									
Stiff mouthpiece lip*									
Hard liners*									
High liner tension*									
Mismatch of liner and teats									
Milking management									
Over-milking									
Long dribble times									
Teat cup crawling									
Chemicals									
Environmental									
Cold, wet, windy									
Mud									
Infectious pathogens									

* For more information on liner characteristics, see the 'Liners' FAQ sheet (February 2003).

This table is intended as an initial guide only. It is rare for a single factor to be the sole contributing cause. Furthermore, some of the factors are inter-dependent (for example, higher vacuum may induce longer dribble times and/or more overmilking). Therefore, the table should be interpreted in conjunction with the results of other milking-time tests and observations using the combined experience of all the members of the investigating team.

9.2 Reduce mud problems by maintaining clean, dry trough areas, farm tracks, laneways, gates, and entrances and exits to the shed.

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9.3 Ensure cows don't have access to creeks, dams and watercourses.

Technote 27 discusses ways to fix areas that make udders muddy.

9.4 Minimise use of water on cows in the dairy.

Technote 5.3 discusses udder cleanliness and pre-milking preparation.

9.5 Check teat disinfectant mix, particularly emollient concentrations.

Revised Technote 7.5 (February 2003) discusses how to maintain teat condition using emollients.

9.6 Check important machine factors.

Technote 6 describes how to monitor and maintain milking machine function.

9.7 Avoid the use of teat ointments, especially those that come in tubs or jars.

Ointments used to improve teat health and condition may have the opposite effect by:

- Increasing teatcup 'crawl'. In one study of the effects of greasing teats, the average strippings yield at the end of milking was trebled when all the regions of contact between the teat and liner were lubricated to reduce friction (Mein et al 1973).
- Exposing the teat end to bacteria. Teat ointments that are dispensed by hands repeatedly dipping into a jar become easily contaminated with environmental bacteria.
- Prolonging the contact time of bacteria on the teat.

It is easier to avoid using teat ointments rather than to work around these issues. However if teat ointments are used:

- choose one of the newer varieties of ointments containing a base such as sorb-ylene or glycerol rather than the oily/grease type products;
- choose a dispensing container that maintains a clean reservoir of product, for example pump jars that dispense a single dose of product; and
- apply them only at the end of milking.

9.8 Seek advice from your veterinarian if problems persist.

Farmers are urged to seek advice from their veterinarian if problems are identified with teat condition.

Many farmers, especially those who have participated in Countdown Downunder Farmer Short Courses, use triggers to identify when their milking system is not operating properly – including assessment of teat condition. Farmer assessment of teat condition covers the same range as described in this Technote, alerting them to changes in teat skin colour, swelling, hardness and teat ends. However, it is the adviser's role to investigate these alerts, including a thorough teat assessment, to better understand the situation.

The Mastitis Investigation Pack in the revised Technote 13 (February 2003) provides a systematic approach to investigating problems.

Key papers

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