Addressing Teat Condition Problems

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Introduction

In this paper the collective experience and knowledge of members of the Teat Club International have been applied to

- describing effective treatments, changes in management or changes in machine settings that appear to provide successful solutions for particular teat condition problems in commercial herds;
- indicating the expected time scale - after the start of a successful treatment or management change - until improvements in teat condition should become evident;
- providing an estimate of the degree of confidence attached to each recommendation or conclusion.

A selection of teat images, illustrating each of the conditions discussed in this paper, can be found in the Teat Condition Portfolio, a CD produced by the Institute for Animal Health, Compton, UK (Hillerton et al. 2001). As an example, the reference (TCCD 2.1) given in the following paragraph refers to category 2, sub-category 1 in the Portfolio.

Short-term, milking-induced changes in teat condition

Short-term changes are generally regarded as those seen in response to a single milking. Faults in milking management or milking machines are the primary cause of short-term effects such as:

- discoloration - that is, reddened, bluish or purple-coloured teats seen immediately after milking (TCCD 2.1)
- firmness or swelling of the teat (TCCD 2.2) or “ringing” around the upper teat barrel (TCCD 2.4)
- wedging of the teat-end (TCCD 2.3)
- degree of openness of the teat orifice (TCCD 2.6.4).

Some specific causes or exacerbating influences on these particular teat conditions are summarised in Table 1, which is derived mainly from text descriptions in Mein et al. (2001).

Generally the teat takes some hours to recover its full integrity even from good milking conditions (Neijenhuis et al., 2001). However, improvement in teat condition should be evident immediately after the milking at which the specific fault or faults have been correctly identified and fixed. Full rectification may take one or more days and be influenced by milking interval.

Degree of confidence	Comment
High	If improvements are not obvious or immediate, then it is likely that the specific faults have not been identified correctly or they were not corrected adequately. (Rasmussen et al.,1998; Hillerton et al.,2000)

Table 1. Some of the common primary causes or exacerbating influences on short-term, machine-induced teat condition.

	Teat colour	Swelling at the base	Firmness/hardness of the teat end		Open orifice
Observation	Red/blue	Ringing	Hard	Wedge	Diameter
Machine factors					
High milking vacuum	✓	✓	✓		✓
Faulty pulsation	✓		✓	✓	
Short D-phase	✓		✓		
Long D-phase				✓	
Liners - wide bore	✓		✓		✓
- aged	✓	✓			
- high tension	✓			✓	✓
Mouthpiece - large chamber	✓	✓			
- small lip diameter	✓	✓			
- stiff lip		✓	✓		
Mismatch of liner and teats	✓	✓			✓
Milking management					
Long dribble times	✓	✓	✓		
Over-milking	✓	✓	✓		✓
Teat cup crawling		✓			

Medium-term, milking-induced or environmentally-induced changes in teat condition

Medium-term changes refer to teat tissue changes that take a few days or weeks to become noticeable.

Machine-induced hemorrhages of the teat skin (petechial or larger hemorrhages) may take several days to become evident (see TCCD 2.5). Such vascular damage usually reflects some type of pulsation failure. If gross or catastrophic, they are often associated with a high milking vacuum or inadequate liner movement. If the damage is chronic it is more likely to result from prolonged over-milking (see Table 2).

Some improvement should occur within a few milkings but significant improvement may take up to 4 weeks after correct identification of the fault and elimination of the cause.

Extreme care must be taken to ensure that vacuum and pulsation issues are considered in conjunction with cluster position and tube support. Where cluster position is poor, eliminating vacuum and/or pulsation faults may not provide a complete solution.

Degree of confidence	**Comment**
Medium-High	Field experience: Field staff are more aware of poor teat condition after cluster removal. Most problems occur with older style milking equipment milking higher yielding cows, poorly serviced and maintained equipment, over-milking or with new installations lacking quality control on the machine set-up (Hillerton et al., 2000; Hillerton et al., 2002)

Changes in teat skin condition associated with chemical irritation (TCCD 3.8)

When teats were intentionally irritated with a harsh chemical (Fox, 1992), the irritant effect was maximized after 1-3 days. Progressive healing from the severe teat skin and teat-end damage can take 3-5 weeks. More typical degrees of irritation resolve in 10-14 days (Rasmussen 2003).

Teat disinfectants more usually induce more significant improvements on teat barrel skin rather than on teat ends, probably because for skin, the disinfectant and the environment are the major influences, whereas the milking process has a more significant effect on the teat end. Overall, both respond in parallel and differ in degree and speed. Skin thickness should not be affected by teat disinfectants. Aggressive chemicals may remove some epidermal layers. This was shown in a case study when teats in a UK herd were sprayed unintentionally with a concentrated, low pH, iodine-based, bulk tank cleaner for three milkings. The burning of teats was severe and took several weeks for the skin to return to visible normality. Further, many cows in the herd seemed to become sensitised to iodine products. Successful restoration of teat condition was achieved using a chlorhexidine formulation with a high concentration of glycerine. It is worth noting that given the dominant use of iodine as the preferred teat disinfectant, sensitisation to iodine is not routinely observed.

Aggressive chemicals may also induce a hyperplasia of the epidermis leading to thickened and scaly skin (TCCD 3.8.0) which will resolve in 7-10 days with use of a milder disinfectant.

The first generation of iodine-based teat disinfectants had a pH 1-2. These still predominate in some markets e.g. Australia and New Zealand. Their aggressive nature is ameliorated by emollients. More recently developed iodophor technologies have a pH of 3.5 or more. They produce little evidence of teat irritation, and sensitivity seems extremely rare. Chlorhexidine solutions are mild in most cases and unlikely to have an adverse effect on teat skin. Other technologies such as glutaraldehydes are not recommended as teat disinfectants in any circumstances.

Improvements in teat skin roughness can be noticed almost immediately after elimination of the specific cause but reach an end point in improvement in 2-3 weeks

Degree of confidence	**Comment**
High	Field experience. Generally the earlier an adverse reaction is identified, the more rapid the rectification. Consistent complete coverage of all teats with disinfectant is required. Concentrated teat disinfectants must be used at the correct dilution rate and correctly mixed. (Rasmussen & Hemling, 2002).

Changes in teat skin condition associated with harsh weather conditions (TCCD 3.6.2).

Changes in teat skin condition occur with harsh or extreme weather conditions, e.g. chapping. If chaps cover the whole teat then the housing or pasture environment is likely to be a major influence. If part of the teat is affected, usually the part outside the teat cup, then the milking parlor conditions contribute. In both cases the effectiveness of teat skin conditioning from good quality disinfection is limiting.

Degree of confidence	**Comments**
High	Prevention and restoration of poor skin condition is aided by full teat coverage with disinfectant. A high emollient concentration is important but may be insufficient with extremely low pH disinfectants (some iodines and DDBSA) (Hemling 2003). When skin condition has deteriorated improvements may take 1-2 weeks after removal of the cause.

Weather changes can cause an almost immediate effect on teat skin roughness. Teat skin and end cracking varies in severity and distribution within 1-2 days under severe winter weather changes, e.g. in Iowa, where the temperature can change 20F^{o} between days and on the low temperature days (0-20^{o}F) the air can be extremely dry (Timms, 2004).

In milder climates, such as in southern Australia, where there can be lots of mud and wind in winter, with siliceous grasses or grazing on brassicas in winter teat chapping, skin roughness and dry skin are highly likely.

Table 2. Primary causes or exacerbating influences on medium-term changes in teat condition induced by milking or environmentally factors.

	Teat skin		**Teat end**
Observation	Roughness, Lesions (e.g., cracks, chaps)	Haemorrhages	Hyperkeratosis
Duration	Medium	Medium	Long
Machine factors			
High milking vacuum		✓	✓
Faulty pulsation		✓	
Long D-phase			✓
Wide bore liners		✓	
High liner compression			✓
High liner tension			✓
Milking management			
Long dribble times			✓
Over-milking		✓	✓
Chemicals	✓		✓
Environmental			
Cold, wet, windy	✓		✓
Mud	✓		
Forage grazed	✓		
Infectious pathogens	✓		

Teat-end hyperkeratosis (TCCD 2.6.1)

Excessive keratin at the teat orifice is described by the thickness of any circum-orifice ring and secondly by the roughness of that ring. The presence and thickness of the ring is infrequent in heifers before calving and very common in machine milked animals (Sieber and Farnsworth, 1981; Shearn and Hillerton, 1995; Neijenhuis, 1998). Once present it appears to vary little in response to milking management or other stimuli. Roughness is much more variable. Machine factors affecting hyperkeratosis are principally vacuum levels, high level of teat compression during liner closure and machine-on time.
The latter is most influenced by presence and threshold settings levels of automatic cluster detachers (Shearn and Hillerton., 1995; Rasmussen., 1993) Faulty pulsation is not indicated by hyperkeratosis.

The amount of hyperkeratosis varies dynamically increasing from calving to peak lactation and then decreasing towards the end of lactation. It also increases progressively with parity (Shearn

and Hillerton, 1995; Neijenhuis et al, 2002). Teat end hyperkeratosis is often influenced by seasonal weather conditions (Table 2).

The extent of hyperkeratosis and the degree to which it can be improved is related to teat shape being worse with long, slender or pointed teats. There may, therefore, may be a genetic influence.

Degree of confidence	**Comments**
Medium/high	In teat conditioning trials a broad range of iodine and chlorine dioxide type disinfectants and emollient levels did not affect teat ring thickness but did influence teat ring roughness (Britten, 2004). Noticeable improvements in teat ring roughness took approximately 4 weeks after elimination of the specific cause.

<u>Other environmentally-induced teat skin conditions</u>

Photosensitisation (TCCD 3.7)
Lesions due to photosensitization are largely confined to non-pigmented areas of skin exposed to sunlight and may therefore be evident on the outer surfaces of light-colored teats of affected cows.

Photosensitization usually occurs when photodynamic agents, mostly derived from plants, are retained in the bloodstream rather than being excreted at normal rates in the bile. Photosensitization may also be secondary to liver damage include lantana poisoning and facial eczema.

Cows with early photosensitization of the teats may be restless and kick at their abdomens (because the affected areas are very itchy). Affected skin becomes red and edematous but changes may not be noticed until the top layers of skin die and become hard, dry and leathery, or sheets of dead skin flake off. In some markets sun blocks, creams or teat disinfectants are available.

Degree of confidence	**Comments**
Medium	Treatment is by removal of the insults, shade from sun and diet. If liver damage has occurred this medical problem is the primary issue.

Insect damage (TCCD 3.4)
Insect damage to teats may be caused by blood-sucking flies (most commonly mosquitoes, midges, sand-flies, black flies or biting flies), nuisance flies or wasps. The cause is usually easy to observe and pin prick wounds or bites, often with an inflammatory reaction, are obvious on the teat orifice or barrel. Nuisance flies exacerbate primary damage by abrasion of wounds to create larger sores.

Teat disinfectants including an insecticide or insect repellent may be available locally and may be effective when combined with a fly management programme.

Degree of confidence	Comments
Low	The trauma is a direct consequence of external influences and may be difficult to control effectively. Suitable teat disinfectants can assist healing but will not remove the initial trauma.

Teat condition problems due to infectious agents

Viruses, purulent or necrotizing bacteria, and fungi are responsible for most infectious lesions of teat skin.

Viral infections vary in 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 post-milking teat disinfection and minimising transmission.

Early generation iodine disinfectants, with low pH, have a virucidal activity. Post-milking disinfectants and emollients reduce the incidence of sores, rough skin, and cracks necessary for viral penetration and development.

Commonly, multi-use ointment containers are the greatest source of new infections from poor hygiene. When treating any lesions with ointments, it is important to use only single-use containers and clean gloves and applicators where necessary.

Pseudocowpox (TCCD 4.1)
Pseudocowpox, a paravaccinia virus causes acute infection in young cows after calving or cows introduced to a herd that has the virus infection. Spread of infection can be relatively slow. Immunity is short-lived, lasting four to six months, and infections can be a chronic problem in some herds. As a consequence, cows in affected herds are likely to suffer repeat infections.

Early lesions are localised, red, edematous and painful. Affected animals resent being milked. Small, raised, circumscribed lesions (papules) may develop in a couple of days and form rough dark-red centres. A characteristic ring or ‘horseshoe’ shaped scab usually heals without scarring in 3-6 weeks.

Milkers may develop localized lesions usually on their hands, i.e. ‘milkers’ nodules’. No specific treatment exists. Spread of infection can be minimized by milking infected cattle at the end of the run and wearing gloves.

Degree of confidence	Comments
High	Success of treatment depends on consistent complete coverage of teats with a licensed and effective disinfectant.

Bovine herpes mammillitis (TCCD 4.2)
Two herpes viruses cause mammallitis. The effects range from sero-conversion with no lesions; cows that become hard to milk showing no lesions; mild lesions that eventually heal; to severe ulcerative lesions that may result in secondary infections and mastitis. When first noticed, many animals especially heifers, may be affected. In some herds the problem is on-going with 5-10% cows permanently affected, in others the number of animals affected and the severity cycles over a few years. The disease varies seasonally being more likely in colder weather. Transmission mechanisms are not fully understood. Recrudescence appears more of an issue in herds when the virus has been present for some time.

Carrier animals may exist, cow-to-cow transmission may occur and milking conditions are probably involved as heifers succumb soon after calving.

Degree of confidence	Comments
Low	Teat disinfectants do not seem to prevent infection but may help teats to heal and prevent secondary infections. Possibly reducing pre partum edema will help in heifers if only to limit skin sloughing and necrosis, more common in heifers. Good milking time hygiene can only be helpful.

Teat warts - papilloma (TCCD 4.4)
Six separate papilloma viruses cause teat warts including the 'rice grain' flat white warts (strain BVP-5), frond-like papillomas that protrude in a ragged fringe of up to one centimetre in length (strain BVP-6) and fibropapillomas that protrude from the teat surface (strain BVP-l).

Young animals are very susceptible to papilloma viruses, and usually develop immunity soon after they enter the milking herd. In older cattle, papillomas are usually confined to the udder and teat. Spread is between animals via teatcup liners and milkers' hands.

There is a wealth of anecdotal evidence that certain areas are more prone to warts, usually areas close to low lying river plains and forestation.

Warts can interfere with the function of the liners and can, in some cases, block the teat canal. If they become damaged, they may be colonised by *Staphylococcus aureus, Actinomyces pyogenes* or *Streptococcus dysgalactiae.*

Degree of confidence	Comments
Medium/high	Teat disinfectants do not seem to prevent infection but may help teats to heal and prevent secondary infections. Possibly reducing pre partum edema will help in heifers if only to limit skin sloughing and necrosis, more common in heifers. Good milking time hygiene can only be helpful.

Most warts are self-limiting and disappear within 5-6 months. The frond type can be physically removed. If there is a major problem in a herd, an autogenous vaccine can be made from wart tissue from cows in the herd. Type-specificity is high, so vaccines must include all serotypes and tissue types responsible for the outbreak. The response of the low, flat warts to vaccination is relatively poor. Teat dipping with a salicylic acid formulation is often used for heifers.

Foot and mouth disease virus (TCCD 4.5)

Common symptoms in cattle are blisters (vesicles) in the mouth and on the tongue and feet, although blisters on teats and udders are also common. In the UK outbreak of 2001 they were often the first signs noted by milking staff. Milk yield drops dramatically with the onset of the disease and the animal is prone to mastitis. Teat blisters and skin erosion caused by FMD are similar and easily confused with teat trauma caused by milking machines, pseudocowpox, bovine herpes mammillitis and chemical burns. Veterinary advice must be sought. The disease can be spread via the milking units, bedding and people.

Although the first signs are blanching (loosely described as whitening or loss of colour) of the epithelial layer of the teat skin, it is normally the fluid-filled blisters that are first noted by the milker. These burst by the second day to leave red, raw patches. Rupturing of the blisters is aggravated by the action of milking. Cows can be difficult to milk due to sensitive teats. Between days 3 and 7 the lesions become less defined and blood scabs begin to form and subsequently scar tissue remains. With time this heals, although may still be evident on examination. Milk yield is often permanently reduced. Many cows will continue to be carriers of the disease. Secondary infections of the ruptured teat skin can occur, where diseased cattle are not culled.

Degree of confidence	Comments
Low	Although vaccination is an option in many countries, the disease control strategy is often to use vaccination to contain an outbreak and then to cull such animals at a later date. Opinion is divided among professionals whether a culling or vaccination policy is the best option. Use of emollients will be highly beneficial in healing teat skin, speed recovery and improve cow comfort. With the large depression in milk yield following the disease, stopping milking will be an aid to recovery of the teat skin.

Vesicular stomatitis (TCCD 4.6)
The signs of this viral infection are indistinguishable from those of Foot and Mouth Disease, although it is less contagious. Vesicular stomatitis is only found within the Americas. It is normally spread by sand flies and black flies, although it can also be spread by direct contact with infected animals, by water troughs and feed bunkers contaminated with infected saliva and via the milking equipment.

In addition to excess salivation and blisters in the mouth and on the tongue, lips and muzzle it is characterised in cattle by lesions on the teats. Blisters burst within 24 hours of first appearing and there is a marked drop in milk yield. Milking can be very difficult, due to the erosion of teat skin, and mastitis is often associated with the teat conditions. It is not uncommon for secondary infections of the affected teats to occur. The disease is generally not life threatening and animals recover in around 2 weeks

Degree of confidence	**Comments**
Medium/high	The virus is susceptible to many of the teat disinfectant products used in the industry including sodium hypochlorite (1%), and iodophors (2%) and their use with a satisfactory level of emollient will aid recovery of affected teat skin.

Bacterial infections of teat skin (TCCD 4.8)
Bacteria cause primary lesions or colonise existing lesions caused by machine-induced damage, environmental factors or viral infections.

Staphylococcus aureus, *Streptococcus dysgalactiae* and *Actinomyces pyogenes* are ubiquitous on the skin of dairy cows. They are a major source of new intramammary infections and clinical mastitis, in lactating and non-lactating cows. It was shown clearly some 30 years ago that chapped teats were highly likely to be infected with *Staphylococcus aureus* or *Streptococcus dysgalactiae*, and that such infections were closely associated with high new infection rates and frequent cases of clinical mastitis (Dodd and Neave, 1970). Even small teat lesions are significantly associated with sub-clinical mastitis and the risk of mastitis increases as the lesions approach the teat canal (Agger and Willeberg, 1986).

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.

Blackspot (TCCD 4.8) is the manifestation of a secondary infection of a teat end lesion by the anaerobe *Fusiformis necrophorum*. The primary lesion is colonized following poor hygiene. The resulting scab is pigmented black by the bacteria. The teat orifice may become blocked, leading to incomplete and very slow milking.

If more than 2 –3% of teats are affected, hygiene should be improved and milking machine function should be thoroughly checked because blackspot is often associated with short teatcup liners, failure of pulsation, excessive vacuum or over milking.

The management of the winter housing also has a significant impact with heavy soiling of free stalls and straw packs increasing the regularity of identification of blackspot.

Degree of confidence	**Comments**
Medium	Management of blackspot in a herd involves: • treating the lesions with hydrogen peroxide or iodine; • using teat disinfection to minimize bacterial infection of lesions; and • checking the milking machine function.

Fungal infections of teat skin.
Ringworm (TCCD 4.7) is caused by the fungi Trichophyton spp. It occasionally spreads to the teat. It is very unlikely to be confined to the teats and udder and is 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, especially wooden parts of housing, for several years.

Various drugs and some vaccines are available depending on the market.

Degree of confidence	**Comments**
Low	It is normal for the infection to pass through a herd. Immunity will follow but not before the majority of animals have become infected. Thorough deep cleansing may be of some benefit.

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