

Clinical Forum - *Staphylococcus aureus* mastitis in cattle



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INTRODUCTION

Staphylococcus aureus is one of the most important worldwide causes of mastitis in cattle. It is responsible for major financial losses in dairy farming and for the culling of many cows. Once cows become infected they pose significant problems. When infections have become established, they are difficult to remove and infected cows are a potential source of infection to other cows. Well-managed herds can reduce the prevalence of *Staph. aureus* intramammary infection to a very low level, because it is usually susceptible to basic control measures. However, it is apparent that not all strains of *Staph. aureus* behave in the same way and those with a more 'environmental' component are most difficult to control. Clinically, *Staph. aureus* presents the veterinary surgeon with various difficulties, some of which will be discussed in this article.

IMPORTANT FEATURES OF STAPH. AUREUS

The most notable features of *Staph. aureus* surround its ability to evade and influence the host immune system. Much research work involving strain typing has shown that important strain differences exist in how contagious, persistent and virulent *Staph. aureus* may be. Different strains have varying properties and these largely govern how *Staph. aureus* interacts with the host. Although the pathogenic roles of all cell surface-associated and secretory factors are not fully established, properties of *Staph. aureus* strains include:

- production of various enzymes and toxins, some of which cause damage to mammary tissue and allow tissue invasion
- an ability to survive in the keratin of the teat canal of healthy cows, a substance normally inhibitory to bacterial growth
- a capability to resist phagocytosis, for example, 'protein A' in the bacterial cell wall of some *Staph. aureus* strains binds to the Fc portion of antibody molecules making the bacteria unrecognisable to neutrophils

- even if phagocytosed, *Staph. aureus* may survive and even multiply inside phagocytes.

As well as these intrinsic properties, many *Staph. aureus* strains have the ability to resist antibiotic therapy. The following traits are considered important:

- Production of beta-lactamase, an enzyme that inactivates penicillin and closely related antibiotics. Probably around 50% of mastitis *Staph. aureus* strains produce beta-lactamase and there is evidence that these strains are more difficult to cure with all antibiotics.
- Establishment of abscesses and fibrosis within the mammary gland that reduces penetration of antibiotics.
- Movement of *Staph. aureus* to an intracellular site where there will generally be reduced concentrations of antibacterial agents.
- The existence of L-forms that are resistant to antibiotics.

Staph. aureus can be retrieved from various parts of the cow and environment although in most herds, infected quarters and teats harbouring the organism are probably the main reservoir of infection. The organism has been isolated from the head, body, legs and nose of cows, from the hands and nose of people, and from the environment such as the milking equipment, bedding materials and watercourses. Maiden heifers are reported as important carriers and reservoirs of infection particularly in the USA, but the significance of this is less certain in the UK. Recent research has highlighted very different behaviour exhibited by different biotypes/genotypes of *Staph. aureus* and this may explain difficulties with managing the disease on some farms.

CLINICAL SYNDROMES

Staph. aureus mastitis presents with varying degrees of severity: peracute, acute, subacute, chronic and subclinical.

The chronic and subclinical forms predominate and on a herd basis, are the most important. The peracute form is usually seen as gangrenous mastitis (Fig. 1) and often results in death. The acute/subacute form resembles other moderate cases of clinical mastitis but commonly develops into a chronic form. Chronic and subclinical mastitis are often associated with fibrosis, abscessation and blocked ducts within the gland (Figs. 2 and 3).



Fig. 1: Peracute gangrenous *Staph. aureus* mastitis in two hind quarters of a five year old lactating cow.



Fig. 2: Burst abscess in the left hind quarter of a cow with chronic *Staph. aureus* mastitis.



Fig. 3: Abscessation and fibrosis in the upper region of the left hind quarter of a cow with chronic *Staph. aureus* mastitis.

OUTLINE OF HERD DIAGNOSIS

A herd problem with *Staph. aureus* can show up in different ways. Spread of the organism within the herd will result in an increase in new infections and a greater number of chronically infected quarters. In this case the clinical presentation is an increasing incidence of clinical mastitis or more commonly (because new infections often take the subclinical form) an increasing proportion of cows (and therefore bulk milk) with raised somatic cell counts (SCC). An alternative presentation may be an increase in reported treatment failures or recurrence rate of clinical cases.

Diagnosis of *Staph. aureus* mastitis is based on bacterial isolation and it is best achieved through the use of laboratories accredited for mastitis culture. A herd screen may be performed on bulk milk, but this lacks the quantitative precision to be anything other than a raw guide to the presence of *Staph. aureus* intramammary infection within a herd. To estimate more closely the significance of *Staph. aureus* on the farm, culture of milk from selected cows is important. Cows with persistently raised SCC should be selected (three consecutive monthly counts $>300,000$ cells/ml is a useful starting point, although sometimes SCC can be lower than this in cows with *Staph. aureus* intramammary infection). A Californian Mastitis Test aids identification of infected quarter(s) for culture in high SCC cows. Similarly, milk samples from clinical cases are necessary and these can be frozen (this tends to increase isolation rates for *Staph. aureus*) and then submitted in batches within 3–6 months of collection. Whilst sampling of high SCC cows can be pre-arranged and therefore carried out at a milking in conjunction with the vet involved, the provision of a milk sample kit with instructions for sample collection is needed for the herdspersons to successfully collect samples from clinical cases before treatment.

Of course, this type of herd monitoring, including bacteriological culture, is ideally carried out as an ongoing scheme to provide an early warning of a pending problem rather than solely in the face of a herd problem.

CONTROL OF *STAPH. AUREUS* MASTITIS

It is certainly possible to maintain a low herd prevalence with $<2\%$ cows infected (in one or more quarters) with *Staph. aureus*. Since in the majority of herds, the most important reservoirs of the organism are infected cows, most control procedures are based on reducing the probability of spread between cows. However, there are other potential sources of *Staph. aureus* associated with the environment and these may be of special significance in particular herds in which the condition is difficult to control with the traditional methods (see later). Sources of

Staph. aureus outside the mammary gland are also the reason why it is virtually impossible to eradicate *Staph. aureus* mastitis from a commercial dairy unit.

There are two overall aims to controlling *Staph. aureus*. The first is to reduce the prevalence of infected quarters within the herds to a minimum, and this effectively reduces the challenge to other cows. The second is to put in place measures that minimise the risk of new intramammary infections and this means preventing spread from cow to cow and secondarily from environment to cow.

REDUCING THE PREVALENCE OF STAPH. AUREUS

The prevalence of infected quarters within a herd can be reduced in several ways. Each has advantages and disadvantages and therefore must be used as appropriate. Important economic decisions have to be made when deciding between strategies, although the lack of solid evidence from independent research in some areas means empirical decisions sometimes have to be made. Reducing the herd prevalence of infection is essentially carried out by treatment, culling, drying off infected quarters and ensuring new heifers/cows are uninfected. These are considered below:

Treatment

As described earlier, *Staph. aureus* has the ability to resist conventional antibiotic therapy. Indeed, the poor response to therapy has resulted in a multitude of treatment protocols and is always the source of some discussion! One over-riding difficulty is that most licensed treatment regimes for clinical mastitis are probably too short to produce good results for *Staph. aureus* mastitis. It is imperative that if treatment regimes are used outside datasheet recommendations, diligence is shown with milk withdrawal periods. The best practice for this is always to test milk from each treated cow for antibiotic residues after the standard withdrawal (7 days minimum), prior to inclusion of milk in the bulk tank.

As well as factors associated with the organism, research has identified various other factors important in determining the likelihood of treatment success. Where possible, it is wise to consider these factors before undertaking treatment. The following are associated with a poorer chance of a cure following antibiotic therapy: more than one quarter of a cow affected, increasing parity, a beta-lactamase producing strain of *Staph. aureus*, treatment not started early in the course of the disease, increasingly high SCC, clinical signs of abscessation/fibrosis within the mammary gland, severe teat lesions, other health problems. An outline, and pros and cons of different treatment strategies are listed below.

Antibiotic treatment during lactation

- Early identification of mastitis is essential and early implementation of treatment is associated with improved cure rates. The ability to identify clinical mastitis varies greatly between herdspersons and stems from observation of the cow, udder, foremilk and in line filters and palpation of the udder.
- Bacteriological cure rates with antibacterial therapy during lactation are generally poor (certainly worse than during the dry period). Research indicates that a cure can be expected in approximately 20–60% of cases.
- Conventional therapy following datasheet dose regimes of typically one to three intramammary tubes covering one to three days is often insufficient for *Staph. aureus* mastitis. Bacteriological cure rates of around 20–30% will be associated with such protocols.
- Prolonged antibiotic treatments can be used, and are generally reported to give improved bacteriological cure rates than conventional regimes. These can be split into stop-start therapies (often termed ‘pulse’ treatments) and continuous therapies. There is limited evidence to clearly suggest one regime above another, although biologically, it is intuitive that prolonged continuous treatments will be more successful than the pulse treatments, which were originally proposed to allow datasheet milk withdrawals to be followed. Longer treatment protocols (possibly 7–14 days in length to simulate a short dry cow treatment) are likely to be most successful for *Staph. aureus* mastitis but more research is necessary to allow evidence based decisions to be made. As stated earlier, ensuring milk remains free from residues is a central issue when undertaking ‘off-label’ prescribing.
- There is a rationale for using parenteral antibiotic therapy in combination with intramammary treatments for *Staph. aureus* mastitis, particularly to improve penetration of inflamed or intracellular sites. Again, length of activity may be important with 5 days probably being a minimum.
- A variety of antibacterial products are available but comparative trials are sparse. It would seem to make sense for the intramammary antibiotic used to have good gram positive activity without being susceptible to beta-lactamase. Parenteral therapy should have similar spectrum with good penetration of the mammary gland and probably intracellular activity.

Antibiotic treatment during the dry period

- Bacteriological cure rates from antibiotic therapy during the dry period are usually in the region 40–80% and therefore the dry period is the time of choice for treating *Staph. aureus* mastitis. Again, the cow factors

described above influence the probability of curing a cow. There is little comparative evidence indicating that any particular dry cow product is best for curing *Staph. aureus* although it is logical to use one of the various products that have suitable activity and remain at a therapeutic level for a prolonged time through the dry period. Selection of particular dry cow products has been described elsewhere and is beyond the scope of this article^{1,2}.

- Dry cow therapy is sometimes supplemented with additional antibiotic treatment before drying off, often called 'end of lactation therapy' (ELT). ELT may be given via the intramammary or systemic routes. It is difficult to objectively assess the efficacy of these treatments and to know if, when and by how much they improve cure rates over the use of dry cow therapy alone. Until this is properly established it is difficult to advise farmers on the cost effectiveness of these alternate approaches.
- An alternative strategy to supplement intramammary dry cow therapy is the use of pre-calving therapy (PCT). This is administering a systemic antibiotic 1–2 weeks before calving, possibly by using an intracellular antibiotic. Again solid evidence is sparse but supplementary treatment during the dry period when natural cure rates are possibly at their best is biologically plausible if not scientifically proven. What is certain is that it is important to target these strategies at specific cows – it is worth considering bacteriology pre-treatment (at drying off) as the cure rates achieved by DCT may already be reasonably high, and again, the cost effectiveness of such a strategy is not established.

Culling

Culling a chronically infected cow with *Staph. aureus* mastitis achieves both a reduction in herd prevalence and also a reduction in the risk of subsequent spread of infection. However, it comes with a cost, a current net loss of around £600 per cow culled. The decision to cull is unfortunately complex and depends on the herd status in terms of somatic cell counts and clinical mastitis and the ability within the herd to prevent the spread of infection (see below); the cost of a cull needs to be tempered by the cost and likely success of treatment as well as by the potential for spread. With the herd position in mind and knowledge of the cow factors described above, a cull/treat decision has to be made. An old cow with chronic high SCC, CMT positive in three quarters and fibrosed mammary tissue is clearly more eligible for culling than a young cow with a recently increased medium SCC, one quarter positive on CMT. However, decisions are not always clear-cut and quantification of these decisions is a subject of current research. It is important to remember

that culling alone is not the answer to a high SCC problem; in the absence of institution of appropriate measures to control spread the end result is likely to be just more culls.

Drying off a quarter

This is a useful compromise measure, an alternative to culling the cow or treating infected quarters. Chronically infected quarters are identified and milking of the quarter is ceased for the remainder of that lactation. Antibiotic dry cow therapy is only used when the other quarters are infused at drying off. This technique works particularly well for high SCC infected quarters but not during a clinical episode. It is important to mark the quarter clearly to prevent accidental milking (common now labour is minimised). Research studies report the use of povidine-iodine or chlorhexidine to 'stop' the offending quarter from lactating but these should only be considered when permanent cessation of milking in that quarter is acceptable – if these measures are adopted it is important to consider the welfare aspects of this procedure and consideration should be given to using appropriate analgesia. Cessation of milking in a quarter for one part lactation essentially gives that quarter a prolonged dry period and is often associated with cure rates of over 50%.

Biosecurity

Maintaining a low prevalence of infection means minimising the risk of introducing infected heifers or cows (whether bought in or home bred) to the milking herd. An individual plan should be drawn up for each farm depending on current infection status and acceptability of risk. In particular, we are concerned with *Staph. aureus* in this article and various considerations include:

- A closed herd is best and should therefore be encouraged as clearly the best way to reduce the risk of introducing mammary pathogens.
- If cows have to be purchased, then a series of investigations/tests should be carried out. This starts with the history of the herd of origin; it should have available evidence of a consistently low SCC and excellent individual cow SCC and clinical mastitis records. Animals to be purchased should have a thorough inspection of the udders, teats and milk before purchase. Any signs of disease prevent purchase.
- Although maiden heifers (pre-calved and newly calved) are generally less likely to be infected with *Staph. aureus* than cows, there is still a risk of an infection having occurred in a heifer prior to the first calving. A problem with purchasing heifers is that there will be no historical SCC records and the only ways to determine an intramammary infection will be from CMT/SCC after calving and bacterial culture.

Therefore, there is good reason to carry out culture on all purchased heifers, but it requires that animals can be milked separately whilst awaiting results, and returned to the seller if necessary. Furthermore, *Staph. aureus* may be shed intermittently in milk and does not always elicit a very high SCC, therefore negative results cannot be an absolute guarantee of freedom from infection. Three weekly SCC (< 100,000/ml) and two negative cultures from newly calved heifers at least suggest the risk of infection is very low.

- If older cows or heifers later in the first lactation are purchased, then SCC records provide a means for assessing infection status. No SCC level will guarantee freedom from infection, but a lifetime with SCC <100,000/ml may be a reasonable starting point. Historical SCC should be supplemented with a CMT (needs to be negative on all quarters), the absence of clinical signs (milk, teats and udders) and depending on the farm status and risk attitude, bacterial culture of a pooled milk sample from all quarters.

CONTROLLING THE SPREAD OF STAPH. AUREUS WITHIN THE HERD

Control of the spread of infection between cows is based mostly on aspects of the milking routine and a correctly functioning milking machine. The aim is to prevent infected milk from one quarter reaching the teat of another cow either via the milking equipment or the milker, and this should be the over-riding thought when assessing parlour routine and plant function. In most instances, attention to detail in the parlour is effective in minimising contagious spread. Environmental sources are less commonly a problem but when present can prove difficult to manage. Important areas of management are listed below.

Parlour

Milking routine

- Milking the infected cows (recurrent clinical cases or SCC > 200,000 cells/ml) at the end of milking reduces the possibility of spread to other cows. This is of particular importance in herds with a high prevalence of infected cows because it is the best way of reducing the level of challenge and hence the new infection rate. Good in principle, this is often a problem in reality, depending on the grouping/housing/feeding routines on the farm. There is often insufficient labour nowadays to be parting out selected cows twice daily before milking.
- No common towels or rags used between teats.
- Use clean, disposable latex gloves and disinfect regularly during milking. Whilst it is common sense to protect dirty cracked hands from contact with the teat, various research studies have failed to show a distinct

advantage of wearing gloves. Indeed, if gloves become contaminated and are not regularly cleaned (and dried), they may even present an added risk in the spread of disease. Hands (gloved or not) should not come into contact with the teat end during milking.

- Foremilking of cows is required but again has to be undertaken with care. Although it helps in the early identification of clinical disease it clearly provides a risk in itself as contaminated milk may be sprayed onto the equipment and milker. Several research studies have shown it is actually associated with an increased risk of mastitis and therefore stripping milk carefully into a container is preferable.
- If infected cows are milked with the rest of the herd, the use of a separate cluster and dump line is preferable. Cluster disinfection/pasteurisation after milking an infected cow is probably a poor second best. If used, cluster disinfection is probably best achieved by flushing with very hot water with disinfectant although it should be borne in mind this is far from perfect.
- Post milking teat disinfection (PMTD) is widely regarded as one of the most important elements for controlling contagious mastitis including *Staph. aureus*. PMTD reduces new infections by killing bacteria that are deposited on the teat during the milking process. Another important role is to preserve healthy teat condition and thereby maintain natural teat defences. The most common disinfectants used in the UK are iodine and chlorhexidine based with emollients. Formulation of dips has been described elsewhere but teat coverage is also important in determining effectiveness. Correct storage and handling of dips is vital. Generally dipping with a teat cup gives more reliable coverage than spraying although if carefully and thoroughly used both methods can work. Around 10–12 ml of disinfectant per cow/milking is recommended when dipping whereas at least 15 ml is recommended when spraying. PMTD should be administered as soon as possible, and certainly within 30 seconds, after cluster removal.

Milking plant

- The milking plant can facilitate transmission of pathogens by acting as a physical vector to transport bacteria between cows, by allowing the flow of milk between teats of an individual cow and by causing teat damage that predisposes to subsequent infection. Therefore, a clean, well maintained machine with appropriate milk flow characteristics is essential. Daily and weekly cleaning and maintenance can be carried out by the herds person according to the manufacturer's recommendations. A full machine test should be performed six monthly preferably by an independent

machine expert. In any *Staph. aureus* investigation a machine investigation is essential. If in doubt, consult an independent expert.

Environmental sources

Although the spread of *Staph. aureus* can usually be minimised with attention to the milking routine and plant, research suggests that some strains of *Staph. aureus* tend to have more of an 'environmental' behaviour than others. Indeed, in these instances, changes to the milking procedure have little effect and sources outside the parlour have to be investigated. Certainly, various studies have reported that new *Staph. aureus* infections can occur during the dry period and in heifers before first calving, clearly at a time when the milking routine can have no impact on new infections. *Staph. aureus* has been retrieved from various parts of the farm including bedding, yards, feedstuffs, non-mains water sources, farm employees, air, equipment and the nose/skin of 'normal' cows/heifers! Fortunately, in most herds environmental transmission appears limited but these other sources need to be considered in herds that do not respond to the common preventive strategies.

Vaccination

Much effort has been directed towards vaccination/immune modulation for prevention and treatment of *Staph. aureus* mastitis. As yet, no commercial vaccines are currently available in the UK and it is unlikely that vaccines themselves will give the whole answer to bovine mastitis for some while yet.

QUESTIONS FOR PANEL:

1. What is your favoured approach to treatment of confirmed *Staph. aureus* mastitis, in a cow that is definitely going to undergo treatment during lactation? Approximately what sort of success rate do you expect?



Steve Borsberry writes:

Provided the cow/quarter(s) are identified early, which may only be visible as a persistent high ISCC and not by clinical mastitis, a course of pirlimycin has been successful (approx 50% as gauged by the resultant ISCC). However, the problem is persuading the farmer that the cow requires treating, which can be extremely arduous.

A course of parenteral antibiotics, during lactation, is not favoured by most milkers.



Jonathan Harwood writes:

For this scenario I would advise one or other of two possible treatments. Firstly, I may recommend the use of tylosin injection intramuscularly at the rate of 4 g (20 ml of a 200 mg/ml presentation) twice daily for five occasions. Secondly, I may recommend a prolonged course of a procaine penicillin/dihydrostreptomycin intramammary combination tube (containing 1 g of procaine penicillin and 0.5 g of dihydrostreptomycin) once daily into each affected quarter for 7-10 days. Appropriate milk withdrawal periods would also be advised.

I consider that the success rates for these treatments are enhanced through my being involved in the decision to treat. I need to examine the cow as well as the SCC records!



Colin Penny writes:

I identify if single or multiple quarters are affected using CMT. If a single quarter is involved then I suggest using prolonged (5-7 day) intramammary treatment with pirlimycin (licensed) or lincomycin (off label). If multiple quarters are affected I suggest a five-day course of tylosin injection. It is hard to assess the level of success as I rarely recommend treatment in lactation but I would expect a success rate of <40%.



Chris Watson writes:

Although the question specifically states treating a cow that is definitely going to undergo treatment I would emphasise the need to be sure and weigh up the prospects for success of each individual cow. As mentioned by the authors the assessment of success is vital if you are going to retain credibility with clients - they always expect too much.

I still think that the best, and simplest, approach is to use a prolonged course of a suitable intramammary preparation. You are delivering huge quantities of antibiotics compared with any parenteral approach. Also remember that these days the vast majority of parenteral preparations are designed to have minimal effect on residues in milk for obvious financial reasons. With a definite diagnosis of *Staph. aureus* mastitis a drug that is likely to have beta lactamase resistance should be used. There are several options available but it is often difficult to get specific information about the ability of a product to resist the beta

lactamase activity of *Staph.* organisms. Use the intramammary treatment once daily for 5 to 7 days but always advise a minimum 7-day milk withdrawal, though with some products it may be necessary to test the milk for residues as well to be certain. The success is often very much influenced by how soon the decision to treat is taken. Unfortunately the interval is often too long because a conventional treatment protocol has been tried first before either a specific diagnosis is made or it becomes apparent that the mastitis is likely to be *Staph.*



Andrew White writes:

I have tried to develop a strategy which will give reasonable results and which is simple to explain to the farmer. If the farmer is able to identify the affected quarter, I infuse that quarter with an intramammary tube, usually of cefquinome, every 12 hours using a total of three, together with an intramuscular injection of the same compound on the first and third occasion. Success with this regime varies from 30 to 60% being the highest in young cows in the first 100 days of lactation, the lowest in old cows particularly in those which were affected in previous lactations and those towards the end of their present lactation.

If the infection is subclinical, with the farmer not able to detect changes in the milk other than with the Californian Milk Test, then again I divide our cows for treatment into those in the first 100 days of lactation and those beyond that stage. The first group I treat with intramuscular injections of tylosin daily for 5 days, those in the second group I suggest removal from the milking herd to be dried off or used to suckle bull calves. If there are other problems with these cows, such as poor fertility or lameness I suggest removal from the farm. The success of treatment for those treated is about 75% based on a check cell count 14 days after treatment.

2. Do the panel use quarter drying off as a control strategy in *Staph. Aureus* herds? If so, what results do you get?

Steve Borsberry writes:

Drying off quarters is a useful method in response to herds with a cell count problem. However, in general, it should be viewed as a 'quick fix' prior to culling. But, as the article points out, if by chance the quarter(s) are milked by accident it has a tremendously adverse affect on BMSCC.

Jonathan Harwood writes:

I have recommended this method of treatment on several occasions. However, I am unable to draw any personal conclusions on its efficacy.

Colin Penny writes:

I suggest this strategy in cows with single quarters affected only when the farmer is reluctant to cull but needs to reduce bulk SCC quickly.

Chris Watson writes:

Drying off individual quarters is often very successful. It may be simple to do but in practice you need to be careful:

- Be sure the client understands what you mean by drying the quarter off. It must be emphasised that this does not imply the use of an intramammary dry cow preparation
- The quarter that is dried off must be closely monitored for several days to make sure that the mastitis does not flare up into clinical disease again
- A system of identifying the quarter should be used, as the cell count could be very high as the quarter involutes and it may well be infective for other animals for a long period of time. Milking it by accident could be a risk to milk quality and other cows.

Andrew White writes:

I have had very little success trying to dry off only the affected quarter. If individual cell counts are available on a monthly basis and I can see three consecutive high figures just prior to drying off, and I know the existence of *Staph. aureus* infection in that herd I have used tylosin as a pre-calving treatment, the cow having been dried off in the usual way with dry cow tubes. This regime has given very satisfying results in some herds but disappointing results in others. I am not sure why there should be a difference.

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3. In practice, what do the panel recommend farmers do, and what is realistically achievable, to minimise the risk of introducing mammary pathogens when new cows are purchased?

Steve Borsberry writes:

In general, unless the current and/or previous lactation ISCCs are available I advise that they could be buying-in trouble. Herds where these ISCCs are not available always give rise to some concern/suspicion. Relying on BMSCCs can be fraught with danger and there are a couple of scenarios:

1. In herds with low BMSCCs there can be a significantly low percentage of 'high cell count' sub-clinical carriers.
2. BMSCCs can be massaged for a few weeks before the date of the sale by discarding 'high cell count' cows' milk.

Relying on mastitis records also gives rise to concern/suspicion:

1. Mastitis cases are not necessarily recorded.
2. Herds with a significant sub-clinical *Staph. aureus* problem do not appear to have a high incidence of clinical mastitis cases.

I do advise that any milking cow purchased should be milked last. In reality, this tends to be a non starter as on most occasions the cows in question arrive overstocked and require milking ASAP. (Deliberate overstocking for sale and other purposes, is in my opinion a welfare problem and should be actively discouraged). The minimum requirements should be CMT shortly after arrival.

I don't know how to get round the problem of bought-in dry cows having not necessarily received DCT. I must admit that I do not have any great concerns about bought-in heifers.

Jonathan Harwood writes:

Purchasing replacement stock always carries risks since even the diseases for which the risks can be considered to be very low will crop up on occasions. In order to avoid introducing intramammary pathogens female replacement stock should, if possible, be purchased prior to their first calving. If cows have to be purchased, then enquiries must be made as to SCC history of the individual cows as well as that of the herd as a whole. It is preferable to scrutinise the SCC records collected at regular milk recordings rather than to rely on a single figure or two in a sale catalogue.

Colin Penny writes:

Being in a low dairy herd density area this is not an issue for us as almost all our herds are closed and therefore rarely buy in lactating cows.

Chris Watson writes:

There is no practical option for safeguarding against replacement animals being infected. The best that you can advise is to always try and buy heifers and preferably calve them down on the farm to minimise the risks of infection at or around calving. If adult cows are purchased then screening them quickly with a California Milk Test is simple and rapid but needs to be done for several days to be sure. It may be possible to use 'separation' techniques (see Q4 below) to make sure newly purchased cows do not contaminate the milking clusters until their status is apparent.

Andrew White writes:

Most of our herds here in Lancashire are, fortunately self-contained. If cattle are brought in then they tend to be either newly calved heifers or older cows of high genetic merit with a well-documented cell count history. A clinical examination of all animals is recommended and is usually carried out. It is not easy to detect udder changes in a newly calved heifer because of the oedema present. The milk is examined clinically but not many farmers will take samples for culture. Separating the purchased animal and awaiting bacteriology results for longer than the usual five-day return-to-seller time being real obstacles.

4. What do the panel consider to be the single most important management policy to control *Staph. aureus* mastitis?

Steve Borsberry writes:

The most significant problems to overcome in *Staph. aureus* problem herds is to persuade the client that they have a mastitis problem. They are aware that they have a cell count problem, and such herds do not tend to have a high incidence of clinical cases. Cows with high ISCCs appear, to the farmer, not to be too adversely affected regarding yield. Due to the intermittent excretion of *Staph. aureus* a negative culture can be difficult to comprehend. The spread can be insidious even on farms that have extremely poor milking routines.

I have tried separate milking groups, identifying carriers, all with limited success rates. *Staph. aureus* herds are chronic herds and long term alterations to milking practices (separate groups, spare units etc. for high ISCC cows) are not accepted by overstretched staff, and there is little point when relief staff fail to abide by the rules. Promotion of good milking routines is obviously useful in all mastitis control programs but may be of limited value in *Staph. aureus* herds, where culling is the only answer to chronic high cell count cows.

Jonathan Harwood writes:

Cull the cows with the worst subclinical mastitis first. This must immediately be followed up with an investigation into the milking machine and how it is used in an effort to prevent another six cows developing a cell count similar to those that have just left the herd.

Colin Penny writes:

Attention to parlour hygiene and effective teat dipping are crucial along with continued monitoring of individual SCC data and having clear action plans for dealing with affected cows.

Chris Watson writes:

The most important thing to aim for is to reduce the rate of new infections – self cure, dry cow treatment or culling will then take care of the infection already present. As the source of new infections is the infected cow then the contact opportunities for transfer of infection must be removed. Isolation of the infected cows from the milking plant must be the key policy to implement. A ‘separation’ technique to ensure the infected cow does not contaminate the clusters or the milkers’ hands means that the chances of spread will be markedly reduced. There was a study done in the USA comparing a good isolation technique alone against intensive treatment with antibiotics during the lactation. The isolation technique produced better results showing a marked drop in bulk milk SCC compared with the therapy herds. Isolation or separation techniques sound impractical to the stockperson but there are simple options as described in the article:

- A separate cluster
- Change gloves after handling an infected cow
- Separate cow group
- Shedding the infected cows at milking into an isolation pen to milk last

This approach relies on being able to accurately identify which are the infected cows.

Andrew White writes:

I consider the most important management policy to control *Staph. Aureus* infection is the strict adherence to hygiene matters in the parlour. This does mean attention to the farmer’s hands, to the cows’ teats and also the machinery involved. The importance of recording systems can also not be overstated.

REFERENCES

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