On Farm Udder Health Programs

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Take Home Messages

- Udder health is not a 'single issue' disease
- Optimizing udder health starts with goal setting
- The economic impact of mastitis management ought to be quantified
- Chronically infected cows cause new infections and should be segregated
- Suboptimal hygiene increases mastitis incidence
- DM intake around calving is important to prevent negative energy balance
- Waiting time before attaching saves machine-on time
- Herd level mastitis treatment schedules should be made and evaluated

Introduction

Mastitis is the most important herd health problem on dairy farms. In addition to the economic consequences of mastitis (Huijps et al., 2008), suboptimal udder health reduces the quality of milk (Ma et al., 2000), increases the risk of antibiotic residues (Saville et al., 2000), decreases work satisfaction of farmers (Jansen et al., 2009) and impairs dairy cow welfare (Milne et al., 2003). For these reasons much research has been done over the years and numerous reports on the subject have been published. Several mastitis control projects have been launched in different parts of the world, such as in Canada: www.medvet.umontreal.ca/reseau_mammite Australia: www.countdown.org.au and the Netherlands: www.ugcn.nl. These have led to several practical guides for farmers (i.e. Hulsen and Lam, 2007).

Farmers and advisors often consider mastitis a complicated disease. They do realize there is often room for improvement, but they either are not convinced of the importance of improving udder health, or do not know how or where to start and how to approach the disease (Jansen et al., 2009). Although several tools for on farm application are available, many farmers are waiting for ‘the golden bullet’, the simple, efficacious and cheap solution for all mastitis problems (Jansen et al., 2010). This paper will show, that the ‘one size fits all solution’ does not exist. Improving udder health is not easy, but hardly ever is technically complicated. Generally udder health can be improved when the herdsman is motivated to do so, and chooses a systematic approach, touching on each of the subjects related to the issue, and calling for specific technical advice when needed.

▪ The Five Point Plan

The standard mastitis prevention program, called the 5-point plan, was introduced in the sixties in the United Kingdom and focused mainly on contagious pathogens such as *Streptococcus agalactiae* and *Staphylococcus aureus.* It focused on milking technique and milking machine; treatment of clinical mastitis; dry cow treatment; post-milking teat disinfection; and culling of chronically infected cows. Although these points are still of utmost importance, the prevalence of contagious pathogens has changed, leading to a (relative) increase of the importance of other pathogens, as is presented in Figure 1 (Sampimon et al., 2009).

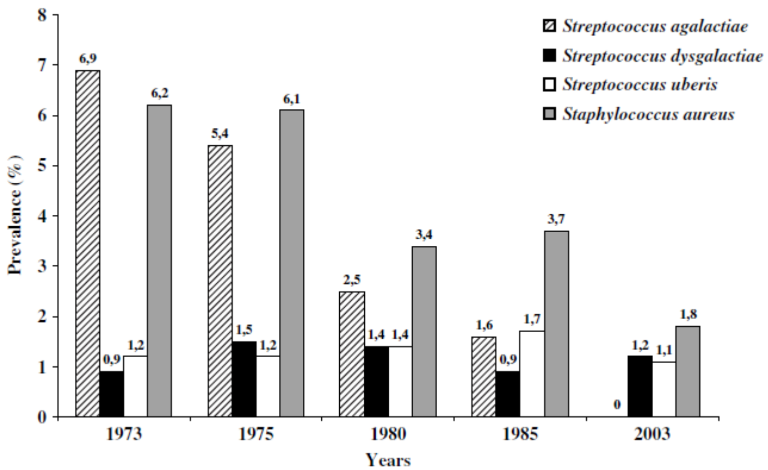

Figure 1. Quarter-level prevalence of the most important major mastitis pathogens in the Netherlands from 1973 to 2003.

The changing proportions of pathogens, with an increasing role of environmental pathogens and the increased knowledge on different subjects related to mastitis lead to an extension of the standard mastitis prevention plan. A whole herd approach has proven to be successful for subclinical as well as clinical mastitis (Green et al., 2007). The five point plan has been updated in recent years as the National Mastitis Council 10 point plan, adding: establishments of goals for udder health; maintenance of a clean, dry and comfortable environment; good record keeping; maintenance of biosecurity; and regular monitoring of udder health status. The ten points in the updated plan are supported by 73 points of attention, and even that long list is not complete. It is beyond the scope of this paper to discuss all possible management measures related to udder health in detail. For practical application of preventive measures, these are summarized in the following headings: goal setting; infectious pressure, host resistance, milking and milking machine, and treatment.

■ Goal Setting

Farmers generally are not used to approaching mastitis, or animal disease in general, quantitatively. Only approximately 2% of farmers have a quantitative goal for mastitis, and 72% of farmers underestimate the economic costs related to udder health (Huijps et al., 2008).

Farmers make many decisions, including those on udder health and milk quality. To make optimal decisions, it is necessary to have reliable data and, although there are more factors than only economics, to have insight in the economic effects of different alternatives. First it is important to quantify the current mastitis situation where, due to seasonal variability, a year is a good period to evaluate. Quantifying the most important udder health parameters helps to visualize the situation, trying to take rational decisions on whether or not to try and improve, and to decide on a realistic goal. For this goal DHI data can be used, completed with data on clinical disease, that have to be collected by the herdsmen. These types of schemes may be incorporated in herd management software, but can also be as simple as Table 1, presented below.

Table 1. An example of a simple sheet to set goals for udder health, starting point of an action plan.

	Results 2009	Goals 2010
Number of cows		
Number of clinical cases		
Average BMSCC		
Percent of cows with SCC > 200,000		
Percent of new cows with SCC > 200,000		
Other aspects		

Generally the most important udder health parameters to evaluate consist of bulk milk and individual SCC and clinical mastitis data. In specific herd situations it may be advisable to add parameters focusing on i.e. cows culled or heifers with mastitis.

Additionally, bacteriological results from across the year may be reviewed. Often these data of individual cows are available, but they are rarely organized and analysed at the herd level. Ideally all clinical mastitis cases are cultured to optimize treatment of individual cows. Alternatively, collect samples of all cases of clinical mastitis, label and freeze them. Samples can then be cultured as required. The distribution of bacterial pathogens should be assessed at least annually and as a minimum, quarter samples from at least 10 high SCC cows and 10 clinical mastitis cows should be cultured.

Based on the data described above it is possible to quantify the current mastitis situation and to set realistic goals for the forthcoming year. This can be further optimized by calculating the economic costs associated with these parameters. In many countries tools are available to calculate these costs (i.e. Huijps et al., 2008). Subsequently the costs of management factors associated with improving udder health can be weighed against potential profit, leading to a business wise cost-benefit analysis of udder health, ignoring other motivating aspects that are important in relation to mastitis (Hogeveen et al., 2010).

Based on an annual review of the udder health status of a herd and on all other relevant aspects, realistic goals for the next year may be set for SCC and clinical mastitis. Only when goals are quantified can one come to an action plan to realize these goals. Action plans ought to be SMART:

- Specific
- Measurable
- Attainable
- Relevant
- Time-bound

Additionally, especially in larger herds, it is important to assign responsibilities for the execution of (parts of) the action plan.

■ Infectious Pressure

Mastitis pathogens can roughly be divided in two groups of pathogens, although that distinction is not ‘black-and-white’ as previously described by Zadoks (2002) and presented in Figure 2. Pathogens such as *Streptococcus* *dysgalactiae* and *Streptococcus uberis* can behave as contagious as well as environmental pathogens, which have to be judged on farm.

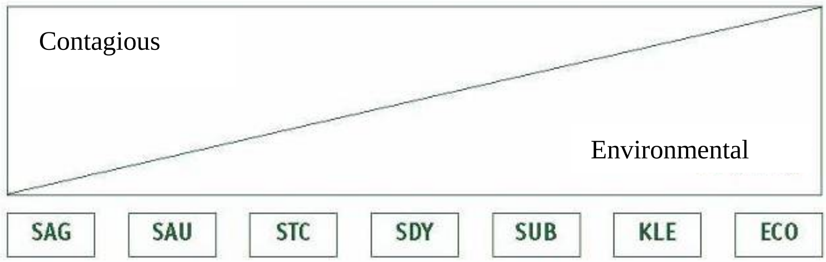

Figure 2. Sliding scale from contagious to environmental epidemiology of mastitis pathogens. SAG = *Streptococcus agalactiae*; SAU = *Staphylococcus aureus*; STC = non-aureus staphylococci; SDY = *Streptococcus dysgalactiae*; SUB = *Streptococcus uberis*; KLE = *Klebsiella spp.*; ECO = *Escherichia coli.*

Contagious pathogens spread from one cow to another, where the number of new infections depends on the rate of transmission and on the size of the source. Contagiousness of mastitis pathogens should not be underestimated. For instance, for *Staph. aureus*, up to seven new infections can arise from one existing infection (Lam et al., 1996). Although transmission of contagious pathogens through the environment cannot be excluded, it mainly occurs during milking via the milking machine (Roberson et al., 1993). Obviously, the other points from the original five point plan on contagious mastitis are also of great importance to reduce transmission of contagious pathogens. To limit the size of the source of contagious pathogens culling of chronically infected cows should be in each action plan to improve udder health. Not only will it be very difficult to cure these animals (Sol et al., 1997; van den Borne et al., 2010), their presence also affects the number of new infections (Lam et al., 1996; Zadoks, 2002). If, for economic or ethical reasons chronically infected cows can not be culled straight away, segregation or the use of separate milking units for cows known to be infected may be an option to prevent transmission, as has been described to be successful for *Staph. aureus* (Wilson et al., 1995).

The effect of housing hygiene on udder health as related to pathogens that infect cows from the environment has been shown in several reports. A significant relation between SCC and leg and udder hygiene scores was described by Schreiner and Ruegg (2003). In an English study performed in herds with low bulk milk SCC, the frequency of mucking out straw yards and the percentage of cows leaking milk outside the parlour were correlated with clinical mastitis (O´Reilly and Green, 2006). Hygiene scoring of udder and leg, using a four-point scale ranging from 1 (very clean) to 4 (very dirty) as described by Schreiner and Ruegg (2003) may be an objective way to judge the infectious pressure from the environment. In a study on 23 herds in the Netherlands the relation between the percent of cows with hygiene score 3 or 4 and the percent of new infections in the herd was confirmed (Figure 3).

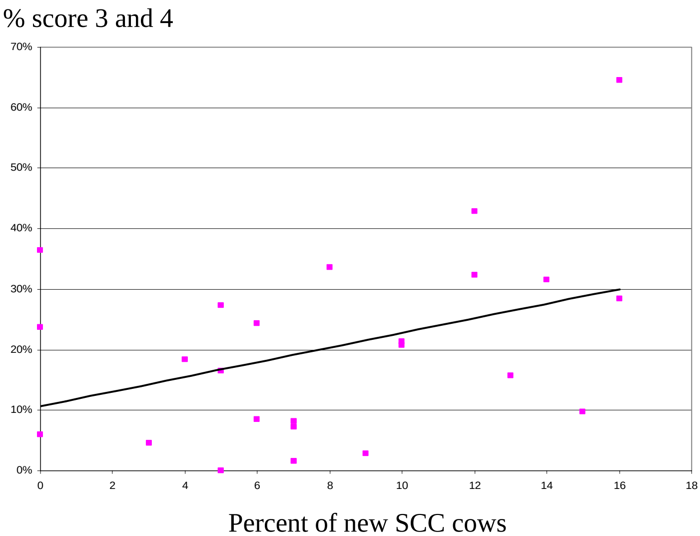

Figure 3. Udder and leg hygiene score in 23 herds as related to the percent of new cows with an increased SCC (>200,000).

▪ Host Resistance

Host resistance is crucial in maintaining good udder health. The most important part of being resistant to intramammary infections, the so-called first line of defence is related to milking: the teat-end. The second line of defence has an immunological background and consists of the stages recognition – alarm – reaction – inflammation – recovery. It goes beyond the scope of this paper to go into detail on these aspects. When a mastitis pathogen enters the udder, there is a massive migration of white blood cells to that quarter, leading to a sharp increase of SCC. If host resistance is good enough, or if adequate therapy is given, the invaded leucocytes will kill and destroy the pathogen and the quarter will cure from infection. If not, the intramammary infection may become chronic, as is presented in Figure 4.

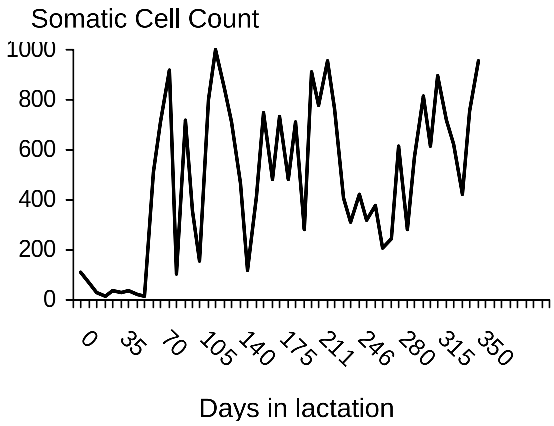

Figure 4. Weekly SCC data from a cow chronically infected with *Staph. aureus*.

Host resistance against certain pathogens such as *E. coli* or *Staph. aureus* may be specifically stimulated by vaccines. In Europe hardly any mastitis vaccines are available, and the author has no practical experience with them. Therefore these are not discussed here. There are several factors that non-specifically influence the second line of defence. External factors such as stress, and diseases like BVD or lameness negatively influence host resistance.

The primary goal is to prevent negative energy balance, as well as deficiencies of vitamins or minerals, specifically selenium (Hogan et al., 1993), copper (Scaletti et al., 2003), and vitamin E and A (Rezamand et al., 2007). Not yet published Dutch results show that giving extra vitamin E to cows without a deficiency may have a negative effect on the occurrence of clinical mastitis. Negative energy balance has a detrimental effect on host resistance, due to either an effect on migration capacity or viability of leucocytes, or to the consequences of a high blood ß-hydroxybutyrate concentration (Kremer et al., 1993). First test day milk yield and the fat to protein ratio as well body condition score (BCS) are important indicators of disease (Heuer et al., 1999). In a study in 52 UK herds, routine BCS at drying off was found to be associated with a reduced rate of clinical mastitis (Green et al., 2007). Both milk yield and BCS should be monitored.

For daily practice the nutritional composition, feeding regimen, and BCS are factors to be influenced. It is important to realize that the energy balance of cows on the top of their lactation is not only influenced by nutrition at that point in time. Contrary, trying to correct a negative energy balance by giving extra concentrate then may easily lead to rumen acidosis with all the negative consequences of that. Dry matter (DM) intake around calving is reduced. It is of importance to try and limit that reduction as much as possible, because it will lead to mobilization of body fat, and thus to increased levels of non-esterified fatty acids (NEFA), which subsequently may accumulate in the liver. This may ultimately lead to fatty liver syndrome. High levels of plasma NEFA and accompanying ketones may lead to decreased appetite and thus to a further decrease of DM intake. Trying to keep DM intake as high as possible on the day of calving is therefore of great importance (Rabelo et al., 2003).

▪ Milking and Milking Machine

The milking-procedure has a big influence on udder health. Experience in milking does not guarantee there is nothing to learn. On the contrary, frequency of training milkers has been related to both efficiency of milking and the rate of clinical mastitis (Rodrigues et al., 2005). Thus, independent judgement may actually improve the milking process. Milking starts in the cow collecting yard. With twice-daily milking, cows should have at most one hour waiting time at each milking (Hulsen and Lam, 2007). Milk letdown is a complex mechanism that should not be disturbed by unexpected actions. The milking routine should be quiet, careful and consistent. Don't, for instance, inject cows in the milking parlour. Pretreatment is crucial for milk let down, and 60 – 90 seconds should elapse between the beginning of pre-treatment and cluster attachment, trying to keep the machine-on time as short as possible (Figure 5).

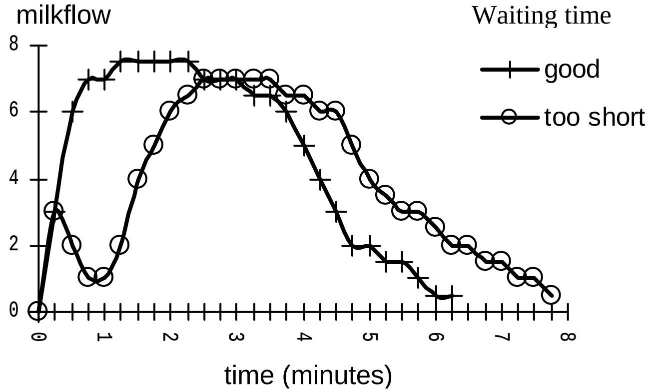

Figure 5. Example milkflow of a cow with too short waiting time between pretreatment and attachment and of a cow with sufficient waiting time.

Milking machines should be mechanically checked at least once every year, preferably during milking. Standard checks should be done, including new insights. In the Netherlands for instance, many automatic detaching devices were found to be activated when milk-flow falls below 200 grams/min or less. With normal variation this may lead to over milking. New insights showed that detaching clusters at 400 grams/min or even higher flow rates improves udder health (Billon et al., 2007).

Scoring teat condition gives a good impression of the functionality of the milking machine and procedure, and many articles have been published on this subject, recently summarized by Ohnstad et al. (2007).

A final point worth mentioning in relation to milking and udder health is teat disinfection. Post milking teat disinfection probably is the most effective single management measure to be taken to fight contagious mastitis. Teat dipping is preferred over teat spraying, because teat spraying becomes less efficacious when teats are only partial covered. By wrapping a paper towel round the teat, the effect of teat disinfection can be made visible in a very evident way (Hulsen and Lam, 2007).

■ Treatment

Although treatment of mastitis cases never solves udder health problems at the herd level, treatment is unavoidable and aids in control. Incorrect therapy may result in disappointing cure-rates, can be a source of new infections (Lam et al., 1996) and some data suggest high usage of antibiotics, especially penicillin and pirlimycin, is associated with prevalence of resistance (Pol and Ruegg, 2007). Thus, optimization of therapy is of importance, starting with correct diagnosis. Timely diagnosis is crucial for successful treatment of both clinical (Sol et al., 2000) and subclinical mastitis (van den Borne et al., 2010). Clinical diagnosis is based on the accuracy and experience of the milker and large differences exist among them. Forestripping is an important part of udder preparation, and is very helpful in detection of mastitis.

Somatic cell count (SCC) is widely used to detect subclinical mastitis. Due to large variability, it is unwise to use a single SCC result as a source for diagnosis at the cow level. Subsequent data, however, are very informative (Figure 4). To further specify the diagnosis at quarter lever, the California Mastitis Test (CMT) can be an inexpensive and easy test. Although the test characteristics are not perfect, the CMT is very practical and has proven its value over many years. It is, however, important to perform the CMT correctly as is presented in simple instruction cards (Hulsen and Lam, 2007).

Bacteriological culture of milk is necessary to reach a definitive diagnosis of the causative pathogen. Selective therapy, that is not using antibiotics in some clinical mastitis cases from which no bacteria or Gram-negative bacteria are recovered is practiced in some regions. Milk samples are cultured before treatment to save costs and to prevent unnecessary use of antibiotics. Time between sample collection and diagnosis is an important factor here, and although on-farm culture systems reduce that interval, their technical results are not always reliable (unpublished results).

The next step to optimize treatments is to make rational decisions on therapeutics and to develop standard herd-level treatment protocols for clinical mastitis and for dry cow treatment. These on-farm protocols may use clinical signs such as general impression of the cow, fever, colour and texture of the milk, to categorize cases and select case-specific therapy. If available, SCC history of cows can also be included. No more than three of four different treatments should be included in the protocol to minimise errors due to excess complexity. Levels of severity might be:

- Local only, e.g. clots in milk
- Diseased cow (fever)
- Very sick cow

The specific treatments recommended depend on available products, price and quality of these products, and earlier culture results. Decisions about dry-cow therapy need to be made at the cow level. Dry cow therapy aims to cure existing infections and to prevent new infections. Selective dry cow therapy (i.e. treatment of a subset of cows based on elevated SCC and/or a history of clinical mastitis) seems economically attractive (Huijps and Hogeveen, 2007). However, as the preventative benefits are lost in the untreated cows, there is an increased risk of new infections over the dry period, which can lead to more clinical mastitis cases during the dry period and during the subsequent lactation (Green et al., 2002). Use of an internal teat-sealant improves prevention of new infections during the dry period of cows (Lim et al., 2007), as well as in heifers (Parker et al., 2007). The cure-rate of intramammary infections depends on therapy, pathogen and cow factors. Historically, most attention has been directed at therapy. Cure-rates, however, are highly dependent on the causative pathogen: *Strep. agalactiae* for instance is easier to treat than *Staph. aureus*. Also, the ‘cow’ effect seems underestimated. Factors like age, SCC and number of quarters infected play an important role, as well as bacterial colony counts in milk, and duration of infection (Barkema et al., 2006). Ensure cows treated with antibiotics are identified. Commonly antibiotics present in bulk tank milk are due to management mistakes (i.e. a dry cow treatment being put in the wrong cow). A standard rule should be to first mark the cow, and then treat her.

Don’t change a treatment if it doesn’t seem to work after one day. Duration of therapy is an important determinant of cure. If the optimal treatment has been chosen, persevere with it. It is also important to give a sufficient dose. For parenteral therapy too often the weight of an animal is underestimated, leading to underdosing. For local mastitis therapy, underdosing may be the result of sometimes not fully emptying intramammary tubes. Simply checking tubes from the trash on the amount of antibiotic left in them can lead to surprising results.

When subclinical infections have to be treated during lactation, attention should be given to suitability of a cow to be treated instead of focusing on the best possible treatments only. For *Staph. aureus*, cure-rate data have been evaluated in detail (Sol et al., 1997). Treatment of young animals is often justified, while treatment of chronic infections in older animals often leads to unnecessary and inefficient use of antibiotics.

▪ Concluding Remarks

Mastitis is a multifactorial disease, and management can go wrong in many places. The 'golden bullet' to solve all problems does not exist and often a check-list is required to manage the disease. For years the five-point plan, nowadays the NMC ten-point plan, forms the basis of that approach. Improving udder health should start with goal-setting, including economic cost-benefit analysis. Before you start moving you better know where you are heading. Evaluation of nutrition, milking and treatment should always be part of a check-list on udder health. A unified approach is required within a herd so that the cows meet the same regimen every milking. That requires planning, often unrelated with technical issues, and more with organisational aspects.

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