New Approaches to Mastitis Prevention

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Take Home Messages

- Average bulk milk somatic cell count differs considerably between provinces. Therefore, the approach to prevent mastitis should differ between provinces.
- *Streptococcus agalactiae* is on the brink of being eradicated.
- Bonus programs for quality milk have a significant impact on bulk milk somatic cell count and the quality of retail milk.
- Antimicrobial resistance is a major public health concern. As a result there is increasing pressure on the dairy industry to reduce the use of antibiotics. Treatment plans for clinical mastitis using on-farm culture are currently being evaluated.
- To be able to farm organically, a dairy farmer needs to be an excellent manager who monitors the mastitis situation closely. Biosecurity is even more important in these herds because of the more limited measures that can be taken to prevent the spread of infection.
- Internal teat sealants decrease the number of udder infections in the dry period considerably.
- The proportion of Automated Milking Systems (AMS) is increasing rapidly. Udder health can be excellent in herds using these systems, but detection of clinical mastitis is difficult in these herds. A study on udder health of Canadian farms using an AMS is needed.

Decreasing Bulk Milk Somatic Cell Count

The standard mastitis prevention program, also called the 5-point plan, was introduced four decades ago. It focuses on contagious pathogens such as *Streptococcus agalactiae* and *Staphylococcus aureus*, and consists of the following five points:

- proper milking technique and well functioning milking machine
- adequate treatment of clinical cases
- whole herd dry cow treatment
- post-milking teat disinfection
- culling of chronically infected cows.

Since the introduction of the standard mastitis prevention program much progress has been achieved in decreasing the prevalence of subclinical mastitis and average bulk milk somatic cell count (BMSCC). The best Canadian data available are from Ontario (Fig. 1). In the first six years of stepwise (50,000 cells/mL per year) decreases in the BMSCC penalty limits that started in 1989 and ended in 1995, dramatic changes occurred. In the 12 years thereafter, however, the average Ontario BMSCC did not change.

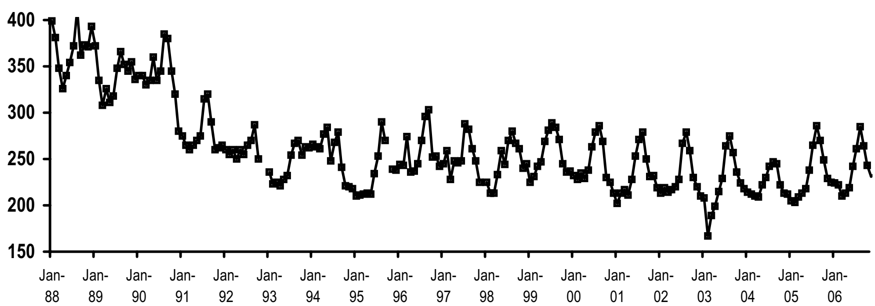

Figure 1. Bulk milk somatic cell count (1,000 cells/mL) in Ontario from 1988 to 2006 (Dr. David Kelton and www.dairyinfo.gc.ca).

The BMSCC is quite different in the 10 Canadian provinces (Fig. 2), and also the changes in the last years differ between the provinces. British Columbia has for a long time the lowest BMSCC of the Canadian provinces, while Quebec until recently had the highest BMSCC. The Quebec dairy farmers, however, have joined efforts to decrease BMSCC. One of the results was the establishment of the Canadian Bovine Mastitis Research Network, a Canada-wide network of 38 researchers that was initiated in Quebec (www.medvet.umontreal.ca/reseau_mammite). As a result Quebec in 2006 does not have the highest BMSCC anymore; that disputable honor is now transferred to Saskatchewan. Another province that decreased BMSCC considerably is Alberta. Its BMSCC is approaching British Columbia's level.

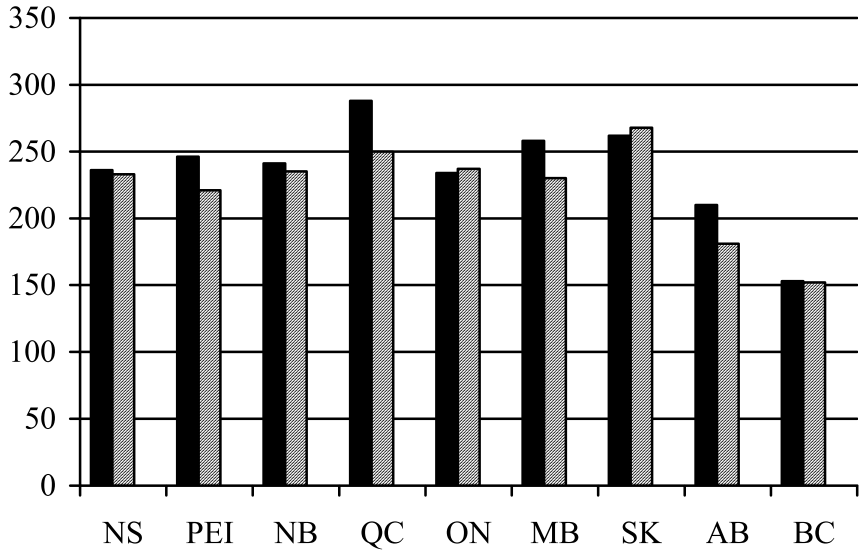

Figure 2. Bulk milk somatic cell count (000's) in the 10 Canadian provinces in 2001 (solid) and 2006 (dashed).

▪ Change in Mastitis Pathogens

Although the incidence of clinical mastitis is not associated with the level of BMSCC, the distribution of pathogens found in both clinical and subclinical mastitis samples is associated with the level of BMSCC (e.g. Barkema et al., 1998; Olde Riekerink et al., accepted). On farms with high BMSCC, contagious pathogens such as *Streptococcus agalactiae* and *Staphylococcus aureus* are the predominant pathogens. In most countries with a developed dairy industry the vast majority of dairy farms have become free of *Strep. agalactiae* (e.g. Sampimon et al., 2008; Andersen et al., 2003). In some countries, e.g. Denmark, and regions mandatory eradication of this infection from the herds that are still positive has been considered (Andersen et al., 2003; Hillerton et al., 2004). Eradication is straightforward if farmers comply with recommended control strategies. Only farms that do not or cannot implement this program (e.g. organic dairy farms with restrictions on use of antimicrobials), are at risk of a major outbreak of infection with *Strep. agalactiae*. If, in a herd that complies with the contagious mastitis control program, a cow with a *Strep. agalactiae* infection is purchased, the likelihood that the infection will spread to a major proportion of the herd is relatively low.

On rare occasions, an animal or bulk tank sample may test positive for *Strep. agalactiae* due to presence of a human strain of the organism.

In herds with low BMSCC, environmental pathogens such as *Escherichia coli*, *Klebsiella pneumoniae* and *Streptococcus uberis* are the predominant pathogens (e.g. Barkema et al., 1998). Prevention of mastitis with these pathogens usually involves changes to environmental factors (e.g. Schukken et al., 1990). Recently, the 5-point mastitis prevention program has therefore been extended to a 10-point program that includes important factors such as nutrition and housing (http://www.nmconline.org/docs/NMCchecklistNA.pdf).

▪ Bonus Programs

Although the effect of a decrease of the penalty limit for BMSCC and also bacterial counts is clear, this only effects farms at the high end of the BMSCC spectrum. Another method to decrease the average BMSCC is rewarding excellent quality milk with a bonus for a low BMSCC. A bonus program for quality milk has existed for more than 25 year in British Columbia. Two years ago the largest dairy processor on Prince Edward Island, Amalgamated Dairies Ltd (ADL), also initiated a bonus program. Although the incentives were relatively small, the program was well-received by PEI dairy farmers, and average BMSCC has decreased considerably (Fig. 2). Even more importantly, the number of complaints by consumers about the product decreased by approx. 100% (Dr. Greg Keefe, personal communication). It is expected, as has happened in the US, that more provinces will follow the lead of these two provinces.

▪ Antimicrobial Resistance

Antimicrobials are vital medicines to treat human infections, but their effectiveness is threatened by overuse and inappropriate use, which contributes to the growing resistance of bacteria. Public health consequences from the excessive use of antimicrobials in livestock production include the emergence of resistant microbes, which can then be transferred to humans through the food chain. Bacterial antimicrobial resistance has become a serious problem worldwide, and mechanisms of resistance have been identified and described for all known antimicrobials currently available for clinical use in human and veterinary medicine. Despite considerable use, and sometimes mis-use, many antimicrobials continue to remain effective today. However, the loss of efficacy through the emergence and transfer of bacterial antibiotic resistance is an increasing reality. Additionally, antimicrobial resistant bacterial pathogens in animals not only pose a risk with respect to animal health but are a growing concern with regard to possible transmission to humans as food-borne diseases (White and McDermott, 2001).

Generally, the presumption is that the rate of antimicrobial resistance is closely associated with the use of antimicrobial agents (Smith, 1967; McGowan, 1983). Using antimicrobials will select for resistance among bacteria causing infection, among commensal bacteria living in the gastrointestinal tract or skin of treated animals as well as bacteria in the animal's environment. Different strategies for antimicrobial treatment will have different impacts on the development of antimicrobial resistance.

Bovine mastitis is the single most common cause for antimicrobial use in lactating cattle worldwide (White and McDermott, 2001). There is a variety of antimicrobials that are used for the prevention and treatment of mastitis. Therefore, resistance to antimicrobials is expected. Bacterial cure rates for mastitis cases (e.g. *Staphylococcus aureus*) using antimicrobials are notoriously less than satisfactory, and seldom exceed 50% (Barkema et al., 2006). Antimicrobial resistance in gram-positive bacteria, typically found in bovine mastitis cases, is of concern due to less efficient antimicrobial options compared to gram-negative bacteria. Resistance to penicillin is most common, where resistance to methicillin is most serious, because these strains are usually multi-resistant (DeVriese and Hommez, 1975). Narrow-spectrum penicillins were introduced in the late 1940s and shortly thereafter, resistance was observed. The rate of narrow-spectrum penicillin resistance varies per country and also over time within countries. For example, in the U.K., penicillin-resistance in *S. aureus* isolated from bovine mastitis has increased from 2% in 1949 to approximately 70% in the 1980s (Aarestrup and Jensen, 1998).

In most North-European countries antimicrobials are used very selectively and can only be applied by a veterinarian. In the rest of the developed world, pressure increases from human medicine to reduce use of antimicrobials in farm animals. Additionally, use of antimicrobials in gram-negative mastitis cases such as mastitis caused by *E. coli* is most likely not necessary. In the Canadian Bovine Mastitis Research Network three research projects are currently being conducted that study the use of antimicrobial drugs and mastitis. Dr. Greg Keefe of the University of Prince Edward Island leads a large study that will determine whether an on-farm diagnosis of the bacteria involved in the clinical mastitis case can lead to reduced use of antimicrobial drugs. In another project of the same network, Dr. Herman Barkema studies the use of antimicrobial drugs and the association between use of antimicrobials on dairy farms and antimicrobial resistance of bacteria isolated from mastitis cases. The Public Health Agency of Canada has recently funded a project to determine the prevalence of methicillin-resistant *Staph. aureus* (MRSA) and extended-spectrum beta-lactamase (ESBL) *E. coli* in milk samples of cows having clinical or subclinical mastitis.

▪ Organic Dairy Farming

Currently, approx. 200 Canadian dairy farms are certified organic producers. Additionally, an increasing number of farms are in the process of converting from conventional to organic dairy farming, particularly in Alberta. Although percentage-wise the number of organic dairy farms is not large, it is increasing rapidly.

On North-American organic dairy farms cows cannot be treated with antibiotics. Therefore, accepted mastitis control and prevention practices such as blanket dry cow treatment are not allowed, while use of antibiotics for treatment of clinical and subclinical mastitis is restricted (compared to not being allowed in US organic dairy herds). Having fewer tools available, organic dairy farmers need to focus more on prevention of mastitis, particularly through maintaining an excellent resistance of the cows to infections. Additionally, an organic dairy farmer needs to monitor the mastitis situation more tightly to be able to correct before a herd problem occurs. It is therefore very important that an organic dairy farm participates in DHI, monitors the BMSCC regularly, and submits clinical mastitis samples for culture, etc.

If an outbreak of an infectious disease occurs fewer measures are available to organic than to conventional farmers. Biosecurity and hygiene needs therefore to be tighter on an organic dairy farm compared to a conventional one.

▪ Internal Teat Sealant

The importance of the dry period with respect to udder health management programs has been well documented. A high proportion of infections and clinical mastitis cases that are detected in the first two months after calving occurred in the dry period (e.g. Smith et al., 1985).

Recently, a new device for prevention of intra mammary infection (IMI) in the dry period, an internal teat sealer, has been approved for use in animals in North America. In all studies being performed quarters treated with both the internal teat sealer and dry cow antibiotic treatment had both a significantly lower incidence of udder infections in the dry period and incidence of clinical mastitis shortly after calving when compared to quarters treated only with antibiotics (e.g. Godden et al., 2003; Sanford et al., 2006). Recently, in Canada, a split-udder designed study on the efficacy of an internal teat sealant (Orbeseal®) was conducted (Sanford et al., 2006). In this study, in cows with at least one quarter that is culture-positive, a similar study-design was used as in the US study (Godden et al., 2003). However, if all quarters of a cow were culture-negative, two quarters of the cow were treated with antibiotics at drying off and in the remaining quarters the internal teat sealant was applied. Cows that were culture-negative at drying off had a significantly lower incidence of new udder infections in the dry period in quarters treated with an internal teat sealant than in quarters treated with antibiotics. Additionally, SCC in the first week after calving was lower in quarters with an internal teat sealant than in quarters treated with antibiotics.

In New Zealand the used of an internal teat sealant was studied in non-lactating heifers (Parker et al., 2007). Its use reduced the number of infected quarters after calving and the incidence of clinical mastitis from which bacteria were isolated by approximately 70%. The situation in New Zealand is, however, quite different from Canada. In New Zealand, *Streptococcus uberis*, an environmental pathogen, is the most common cause of mastitis (in heifers and older cows), while in North-America of the major udder bacteria *Staph. aureus* is the most important cause of heifer mastitis. Application of any treatment in the udder of a non-lactating heifer has to be carried out very hygienically, and its application is not easy and sometimes even dangerous to the person applying the treatment. Therefore, the use of internal teat sealants in North American non-lactating heifers can not be recommended yet.

An internal teat sealant is an important tool in prevention of new udder infections during the dry period. Also, the incidence of clinical mastitis, particularly by *E. coli*, is significantly reduced when this internal teat sealant is applied. Currently, the internal teat sealant is marketed as an additional product next to dry cow treatment. However, in Europe it is also used without a treatment with antibiotics in the udder in cows that have a low SCC at drying off. In low BMSCC farms in Canada this may also be an option. However, hygiene at application has to be very strict. If not, clinical mastitis may occur one or two days after application.

▪ Automated Milking

The first commercial automated milking system (AMS) was installed on a Dutch dairy farm in 1990. The first AMS was installed in Canada in 1999. Although the number of Canadian dairy farms with an AMS increases significantly, only approximately 1% uses an AMS, most of them Lely Astronaut and DeLaval VMS systems. In the US the number of AMS is even lower. So, AMSs are still rare in North America, while in The Netherlands (country with the most AMS) more than 2000 units have been sold. Main reasons for the slow adoption in North America are: 1) costs of milking labour are lower compared to Northern Europe, and 2) the lower and more volatile US milk price compared to Northern Europe. The question is not anymore whether an AMS can work on a dairy farm, but more whether it is economically wise to purchase one under Canadian or US dairy farming circumstances. An additional problem in North America is that the cows seem to adapt slower to the AMS than in Europe. Cow traffic is a problem, because the cows are simply less aggressive in moving. Currently, research is conducted to find out why this is the case.

In a survey on 10 US and 15 Canadian farms using an AMS all farmers reported that they were satisfied with the AMS (www.uwex.edu/uwmril/pdf/RoboticMilking/03_ASAE_033018_SurveyManagementPractices.pdf). Most users indicated that the AMS has given them more time for managerial tasks and their family. They also indicated that the introduction of the AMS has decreased the stress level on them and on the cows.

Udder health has been a problem on some farms that milk using an AMS. In a Danish study, BMSCC, bacterial count, spores of anaerobic bacteria, and freezing point increased after introduction of an AMS (Rasmussen et al., 2002). The problems reduced when farms used a program to decrease these problems in the period of transition to an AMS. However, these data are more than eight years old and AMS has improved considerably. Additionally, no data are available on udder health of Canadian farms that moved to using an AMS. Several research projects are being conducted worldwide to improve detection of clinical mastitis on farms using an AMS.

More background information on AMS can be found at the following web-sites:

www.uwex.edu/uwmril/pdf/RoboticMilking/02_Toronto_AMS_in_the_USA.pdf;

www.iah.bbsrc.ac.uk/BMC/2002/2002%20papers/Papers%20-%20PDF/pp68-80%20Koning.pdf;

http://dairy.osu.edu/resource/Rodenburg%20paper2.pdf.

A lot more information is available on the internet. A search using one of the search engines (e.g. Google, Altavista, Yahoo) using ‘automated milking system’, ‘AMS’ or ‘milking robot’ will result in many ‘hits’.

▪ Conclusions

An increasing percentage of dairy farms have a low bulk milk SCC. Mastitis management in these herds is different from farms with a higher bulk milk SCC, partly because of a different distribution of bacteria that cause mastitis in these herds. Internal teat sealants have become an important tool in the prevention of infections in the dry period. Several important changes in management of dairy cows, such as introduction of automated milking systems, restriction of use of antibiotics and an increase in the percentage of organic herds, are taking place in northern Europe and are starting to affect the Canadian dairy industry. These changes will have a large influence on the prevention and control of mastitis.

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