AUTOMATIC MILKING AND UDDER HEALTH: AN OVERVIEW

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1. INTRODUCTION

The first commercial automatic milking system (AMS) was installed on a Dutch farm in 1992. AMS was installed at a slow pace in the beginning, but the numbers increased heavily from 1998 (Koning & Rodenburg, 2004). The main motivations for European farmers to invest in an AMS are social reasons and saving of labour whereas economy is not a top priority although important. One of the major driving forces behind a good economy is an increase in milk yield, but an improvement of animal health and welfare was also expected. Lind et al. (2000) discussed the expected influence of automatic milking on udder health. Cows are milked more often which leaves less time for bacteria to develop in the udder in between milkings. However, teat canals are also opened more often with the more frequent milking, which may cause a higher risk of bacterial invasions. The more frequent milkings also increase the overall machine-on time whereby teat condition may be negatively influenced. A potential positive effect is that quarters are milked individually with the opportunity to avoid overmilking. The long milk hoses make cross contamination within cow negligible and efficient flushing of the teat cups between the milkings of each cow eliminates contamination between cows. All things considered, we expect the individual quarter milking to favour the udder health.

Some of the first findings from 28 Dutch AMS herds from 1996 to 1998 showed that bulk milk SCC was higher in herds with automatic milking than in herds milked 2 or 3 times daily (Klungel et al. 2000). However, bulk milk SCC of these herds was already higher in the year before introduction of AMS. Rasmussen et al. (2002) analysed development of milk quality of the first 98 AMS herds in Denmark. Bulk milk SCC increased significantly after introduction of AMS. Introduction of a self-monitoring program reduced the negative effects of AMS on bulk milk SCC and after a year the frequency of bulk milk SCC > 400,000 cells/ml was as in the year before milking with AMS. Rasmussen et al. (2002) conclude that there is an indication that milk from clinically infected cows and of cows with high SCC is not diverted to the same degree when milking automatically than when milking conventionally. The systems for automatic detection of mastitis have improved in automatic milking in Denmark over the years. However, systems are mainly developed for providing an alarm list to the farmer of potentially mastitic cows and not meant to be used for automatic diversion of abnormal milk (Rasmussen, 2004). The technical
performance of the systems has improved over the years and it seems as if the frequency of successful milkings has improved. This may influence the ability of the detection systems to point out cows with mastitis, make the farmer act, and thereby improve milk quality.

The information of automatic milking on udder health in the literature is mainly limited to analysis of bulk milk SCC and of cow SCC whereas studies on new infection rates are sparse and limited to studies on very few farms. It is important that analyses of cow SCC are not done only on simple means since milking frequency and method of sampling differ from that of conventional milking. Rasmussen et al. (2001) found an increase in the frequency of suddenly elevated cow SCC with the introduction of AMS, which is a strong indication that the new infection rate also increased.

The objective of this paper is to evaluate the influence of automatic milking on udder health through an analysis of individual cow SCC and treatment for clinical mastitis in all Danish AMS herds. The discussion of the results is supported by available literature.

2. MATERIAL AND METHODS

All Danish AMS herds are enrolled in a self-monitoring program, which gives access to information about date of installation, AMS model, bulk milk quality, and individual cow data from the monthly milk yield recording. Data were extracted from the databases from January 1, 1996 to December 31, 2005 from all herds that had milked automatically within this period. We had data from 478 farms of which 61 had stopped milking automatically. Data were analysed from one year before installation of AMS until the end of 2005 or until the farm stopped with AMS. The dataset included almost 2 million milk yield recordings. The monthly milk yield recordings were used to calculate two variables describing a sudden significant increase in cow SCC (acutely elevated SCC) and a chronically high SCC (elevated SCC) as described by Rasmussen et al. (2001). The frequency of acutely elevated SCC was calculated with respect to cows at risk and thereby reflects the rate of new infections. Mixed models accounting for repeated measurements were used.

3. DEVELOPMENT IN BULK MILK SCC

Bulk milk SCC of herds with AMS followed the seasonal variations of all Danish herds, were much higher during the first years and decreased steadily (Figure 1). However, bulk milk SCC of all Danish herds improved even more leaving a gap up to the AMS herds. The big improvement of bulk milk SCC of AMS herds after 1999 is ascribed to the introduction of the Danish self-monitoring program (Rasmussen et al. 2002). Bulk milk SCC reflects the payment politics of the dairy companies and management decisions of the farmers. But, reliable tools to point out cows with mastitis are also needed in order to meet expectations and benefit from milk quality premiums. Reports from the introduction of AMS to the first 52 herds in Sweden also showed an increase in bulk milk SCC and the authors speculated that the increase could be due to an increase in new infections (Everitt et al. 2002).

Cells/ml
The percentage of cows with acutely elevated SCC increased suddenly with the onset of automatic milking (Figure 2). The frequency was high during the first three months with AMS and then dropped slightly, but was still higher one year after the introduction of AMS than when milking conventionally. This is in agreement with the analysis of data from the first 69 AMS herds in Denmark (Rasmussen et al. 2001). There are five different brands (models) of AMS on the Danish market and all of them experienced an increase in the mean frequency of acutely elevated SCC during the first year with AMS (Figure 3). The frequency stayed higher throughout the first four years with AMS in comparison with the year when milking was done conventionally. The frequency of acutely elevated SCC did not depend on the starting year of the installation indicating that the new infection rate was about the same of AMS herds starting in 2005 as in herds starting in 1998 (Table I).
Table I. Mean, acutely elevated and elevated SCC of cows during the first year with AMS depending on year of installation in 478 Danish herds

<table>
<thead>
<tr>
<th>Installation year</th>
<th>Log cow SCC</th>
<th>Acute SCC</th>
<th>Elevated SCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>5.18</td>
<td>19.1</td>
<td>17.9</td>
</tr>
<tr>
<td>1999</td>
<td>5.18</td>
<td>17.9</td>
<td>16.9</td>
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<tr>
<td>2000</td>
<td>5.18</td>
<td>18.6</td>
<td>16.9</td>
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<tr>
<td>2001</td>
<td>5.15</td>
<td>16.7</td>
<td>17.1</td>
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<tr>
<td>2002</td>
<td>5.17</td>
<td>18.1</td>
<td>18.0</td>
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<tr>
<td>2003</td>
<td>5.20</td>
<td>17.7</td>
<td>17.2</td>
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<tr>
<td>2004</td>
<td>5.20</td>
<td>17.0</td>
<td>16.2</td>
</tr>
<tr>
<td>2005</td>
<td>5.23</td>
<td>17.1</td>
<td>16.6</td>
</tr>
</tbody>
</table>

5. CHRONICALLY ELEVATED SCC

The frequency of elevated SCC was about 17% and did not change significantly from the year with conventional milking to the years with automatic milking. Some AMS models had smaller changes in the frequency of elevated SCC, but there were no specific developments in the numbers (Figure 4). The frequency during the first year with AMS did not depend on the year of installation (Table I). Average cow SCC increased during the first months after the introduction of AMS and then stayed at a slightly lower level than when milking conventionally. A study conducted in the Netherlands confirmed that cow SCC increased when milking automatically no matter if the herds were milked two or three times daily before installation of AMS (Kruip et al. 2002). The Dutch study included AMS farms from 1998 to 2000. Poelarends et al. (2004) reported from 15 newer AMS farms that SCC increased after the introduction of AMS and that the increase mainly occurred among 2nd and 3rd parity cows.

Figure 3. The percentage of cows with acutely elevated SCC in the year before automatic milking (year 0) and in the first 4 years with AMS of the 5 different models of AMS in Denmark
6. TREATMENT OF CLINICAL MASTITIS

The percentage of cows treated for clinical mastitis increased slightly from the year with conventional milking to the first year with AMS and then dropped from about 20% to about 14% (Figure 5). Bennedsgaard & Pedersen (2005) analysed the total number of treatments in 18 herds one year before and after installation of AMS. They found a small increase in the treatments of clinical mastitis at the introduction of AMS, but there was no overall trend in the changes.

7. DRY QUARTERS

Milking of cows with dry quarters requires more attention during attachment and the cluster may slip more often when milking conventionally. These problems do not exist when milking automatically since quarters are milked individually. Bennedsgaard & Pedersen (2005) analysed
milking data from 18 Danish AMS herds. The frequency of three-teated cows increased from about 7% to about 12.5% within six months after the start of automatic milking (Figure 6). In some of the herds more than 25% of the cows had one or more non-functional quarters. Some of the cows were three-teated from the beginning of the lactation but often a low quarter milk yield following clinical mastitis was given as reason for culling a teat (Bennedsgaard & Pedersen, 2005).

Figure 6. The frequency of dry quarters during the first year (days) with automatic milking in 18 Danish herds (Bennedsgaard & Pedersen, 2005)

8. **MASTITIS CAUSING PATHOGENS**

Pedersen and Bennedsgaard (2005) sampled 18 Danish herds about one month before and one and 12 months after the introduction of AMS. There were no changes in the prevalence of quarters infected with *S. aureus, Str. Dysgalactiae* or *S. uberis*. The prevalence of quarters infected with CNS increased insignificantly in 1st parity cows from 10 to 12% whereas the increase from 14 to 23% of older cows was significant. The authors conclude that the automatic milking and cleaning methods may favour the growth of some species of CNS, but further studies have not been carried out to verify such an explanation. The drop in daily quarter milk yield was highest of quarters infected with *Streptococcus dysgalactiae* (5.4 kg) and lowest of quarters having clinical mastitis due to CNS (2.0 kg), whereas *Staphylococcus aureus* and *Streptococcus uberis* resulted in milk yield losses of about 2.5 kg (Rasmussen, 2005).

9. **DISCUSSION**

Changes in bulk milk SCC occur at introduction of automatic milking and several studies have shown that a higher bulk milk SCC can be expected when milking automatically. Bulk milk SCC depends on the udder health but also on management decisions of when to treat or cull cows with subclinical or clinical mastitis. Information about clinical mastitis of herds milking conventionally is mainly captured during manual foremilking, but suspicion may also be based on animal behaviour, development in cow SCC or CMT-scoring of cows at risk. Farmers with automatic milking systems depend on reliable tools to detect cows with mastitis. The present systems are mainly based on measurement of quarter milk conductivity from which an attention list is produced. The sensitivities of the systems are moderate to low (Rasmussen, 2004), which makes it necessary to support the automatic measurements with manual observations for mastitis detection. Systems with a low specificity cause the attention list to be unreasonably long, hide the true positives and
force the farmers to use other means to point out cows with clinical mastitis (Bennedsgaard et al. 2004). Analysis of quarter milk yield of cows treated for clinical mastitis indicates that treatments are carried out late whereby more cows will be systemically ill and the reduction in milk yield more pronounced (Rasmussen, 2005). Unsuccessful milkings will aggravate the situation and especially if the milking interval of the quarter with clinical mastitis becomes longer. Rasmussen (2005) found an increase in the milking interval of cows with clinical mastitis of about two hours and the frequency of unsuccessful milkings increased from about 5% to about 30% on the day of treatment. Unsuccessful milkings cause cows to leak more milk (Stefanowska et al. 2000) and is a potential risk for poor udder health.

Changes in milking interval and frequency of unsuccessful milkings cannot be expected to influence udder health directly and especially not the rate of new infections. Analysis of the Danish data shows that the new infection rate increases after installation of automatic milking. However, only the prevalence of CNS-infected quarters seemed to increase (Pedersen & Bennedsgaard, 2005). CNS normally causes moderate increases in SCC, but high enough, however, to make it count as a sudden and significant increase. Reasons for the increase in CNS should probably be found in changes of teat condition and especially of the teat ends or in changes of the teat cleaning procedure. We would have expected an increase in the frequency of S. uberis and coliform mastitis if teat cleaning and/or stall hygiene were a major problem. A Finnish study revealed that only 80 to 85% of the teats were cleaned correctly (Hovinen et al. 2005), which makes even heavier demands on the barn hygiene. If loads of bacteria are present on the teat at attachment, either growth in the teat canal must be favoured and/or forces acting during milking that bring bacteria across the teat canal for the new infection rate to increase. Such evidence is still lacking.

10. CONCLUSION

Udder health of herds milked automatically is poorer than when milking conventionally, which causes cow and bulk milk SCC to increase. Udder health has not improved over the years with automatic milking in Denmark. Farmers adapt to this situation by increasing the frequency of cows with one or more non-functional quarters.

11. SUMMARY

Automatic milking systems (AMS) were introduced to commercial farms in 1992 and are now frequently installed world-wide. The first analysis of the milk quality indicated an increase in bulk milk somatic cell count (SCC) when milking automatically and this tendency has been confirmed later on. Bulk milk and cow SCC of 478 Danish herds with automatic milking were analysed from one year before installation until the end of 2005 or until the herd stopped with AMS. Bulk milk SCC has improved since the first Danish installations in 1998 but is still not quite at the level of conventional herds. The percentage of cows with acutely elevated SCC increased with the onset of automatic milking dropped slightly after the first months, but then stayed higher than before introduction of AMS. The percentage of cows treated for clinical mastitis dropped after the first year with AMS. I conclude that udder health of herds milked automatically is poorer than when milking conventionally, which causes cow and bulk milk SCC to increase. Udder health has not improved over the years with automatic milking in Denmark. Farmers adapt to this situation by increasing the frequency of cows with one or more non-functional quarters.

12. KEY WORDS

Automatic milking systems, udder health, SCC.
13. RESUME

Les robots de traite ont été introduits dans les élevages à partir de 1992 et sont maintenant fréquemment rencontrés dans le monde. Une première étude sur la qualité du lait indiquait une augmentation du nombre de cellules somatiques du lait de tank (CCS) lors de traite automatisée et cette tendance a été confirmée par la suite. Les CCS de lait de tank et de laits individuels provenant de 478 élevages bovins danois pratiquant la traite automatisée ont été analysés sur une période démarrant un an avant l’installation de l’AMS jusqu’à la fin 2005 ou l’arrêt de l’utilisation de l’AMS dans l’élevage. Le CCS des laits de tank a augmenté depuis les premières installations danoises en 1998 mais il n’atteint pas encore le niveau des élevages traditionnels. Le pourcentage de vaches, qui présentaient une augmentation élevée de CCS lors de la mise en place du robot, décroît progressivement dans les premiers mois, mais reste supérieure au pourcentage observé avant l’introduction de l’AMS. Le pourcentage de vaches traitées pour mammite clinique décroît après la première année qui a suivi l’introduction de l’AMS. De cette étude, nous concluons que l’état sanitaire de la mamelle est plus mauvais dans les élevages à traite automatique que dans les élevages à traite conventionnelle, ce qui se traduit par une augmentation du CCS du lait individuel et de tank. La qualité sanitaire de la mamelle ne s’est pas améliorée ces dernières années au Danemark avec l’arrivée de la traite automatisée. Les éleveurs s’adaptent à cette situation en conservant dans leur cheptels des vaches possédant un ou plusieurs quartiers non fonctionnels.

14. MOTS CLES

Robot de traite, qualité sanitaire de la mamelle, CCS.

15. REFERENCES


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