Research Project Veterinary Medicine University Utrecht.

The variation in treatment policy between AMS and CMS farmers

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Summary

This study was conducted to describe variation in treatment policy between automatic milking system (AMS) and conventional milking system (CMS) farmers, and identify associations between treatment policy, antimicrobial use and udder health on these farms. In total 42 farmers participated (AMS = 18 and CMS = 24) and gave their consent to use their Dairy Herd Improvement records and antimicrobial usage for this study.
The farmers were interviewed about their mastitis treatment policy by telephone, using a questionnaire. The results of this study revealed that AMS and CMS farmers are remarkably similar in their treatment policy, antimicrobial use and mastitis situation. No significant differences are found about: Grading the mastitis, treating the cows, which kind of antibiotics farmers use. Still, AMS and CMS farmers differed in their definition of clinical mastitis and in how farmers diagnose clinical mastitis.

Introduction

Mastitis is an important disease affecting dairy cows worldwide. Mastitis is a frequently occurring disease resulting in a decrease of the milk production among dairy farms which results in economic losses. Mastitis is an inflammation of the udder tissue and can appear as either a clinical or a subclinical infection (1-7).
The main difference between clinical and subclinical mastitis is, the presence of visible signs. The appearance of the milk may have changed. The milk can be discoloured, can contains clumps, flakes, pus, blood or can be watery. If abnormal milk is the only symptom the mastitis can be classified as mild. The infected quarter of the udder can be swollen, red, can have a higher temperature and can feel more firm. If this is the case it can be classified as moderate (abnormal milk accompanied by the mammary gland). The clinical mastitis can be classified as severe, when the cow exhibited systemic signs of illness (2, 8, 9).
Subclinical mastitis is not visible on the outside like clinical mastitis but it implies a bacterial infection without the clinical signs of inflammation, even the composition of the milk looks no different. The difference with normal milk is the somatic cell count (SCC). It is much higher than it should be and bacteria can be cultured from the milk. A high SCC means there are too many inflammatory cells present in the milk derived from the infected quarter (7, 10-13).

There are over 135 different micro-organisms found in udder tissue that can cause inflammation, but the majority are Staphylococci, Streptococci and Gram-negative bacteria. When a cow is showing clinical symptoms or when there is evidence of a subclinical infection, lactating cows may be treated for mastitis. It is imported to treat infected cows since they are a permanent source of infection and the prevalence of mastitis in a herd can be reduced by shortening the duration of the infection. Mastitis is the most frequent reason for antibiotic use in dairy cattle. A non-antibiotic method can be frequent milk out of the infected quarter (2, 11, 14-17).

The somatic cell count (SCC) of the milk is a strong indicator of udder health and milk quality at individual cow levels. A healthy udder produces milk with a SCC between 50,000 and 100,000 cells per millilitre. A SCC greater than 200,000 cells/ml is assumed to be a threshold distinguishing a healthy udder from a diseased udder. The upper limit for SCC in milk is set on 400,000 cells/ml. If the clinical mastitis is not treated, it can develop into a subclinical mastitis. Increased SCC is an indication of mastitis in general (8, 11, 18-20).
All milk produced by the lactating cows on the farm is collected in the bulk milk tank, when the milk is collected from the farm, a milk sample is taken to determine the bulk tank somatic cell count (BMSCC). When there are lots of cows with a high SCC on the farm the BMSCC elevates. It is considered that a BMSCC $\leq$ 150,000 cells/ml is low. A BMSCC between 150,000 and 250,000 is considered as suspected, and a BMSCC $\geq$ 250,000 cells/ml is high (21-23). The BMSCC is limited to a threshold of 400,000 cells/ml, by law in the European Union (19).

The best approach for treating clinical mastitis is to take a milk sample from the infected quarter of the cow and sent it for bacteriological research. Within 24 to 48 hours the results are identified. The bacteriological research has to be done to know which bacteria is causing the mastitis and with that given information an effective, targeted treatment can be provided to the affected cow. However, bacteriological research has not been routinely used by many dairy farms because of the time delay between presenting of milk samples and reporting of results. The treatment protocol of the farm describes the actions the farmer needs to do in certain situations. The cows are often treated straight away following the treatment protocol without the costs of culturing (1, 2, 17, 24, 25).

On farms with a conventional milking system (CMS), collecting milk is being done in presence of the farmer. The milking frequency and interval are similar for all the cows (26). The udder has to be prepared before collecting the milk, the teats are pre-milked, cleaned and then attached to the milking cluster by the farmer. After milking, the farmer has to detach the cluster and disinfect the teats. When abnormalities are found during milking the farmer can decide whether or not to treat the cow based on his observations (5).

Over the years several changes did occur in the dairy industry. One of these changes is the introduction of the automatic milking systems (AMS) approximately 20 years ago. Nowadays the number of installations is still increasing rapidly (27, 28). The use of AMS provide farmers more freedom compared to CMS, and the AMS gives the opportunity to increase milking frequency resulting in an increase in milk production. Also the cows have the freedom to control their activity, which can reduce stress. Technologies of the AMS gives the opportunity of monitoring and recording increasing amounts of data without the presence of the farmer (5, 20, 27). Everything on the AMS is fully automatic, automatic teat-cleaning, milking and at the same time the AMS will check the milk using several in- or on-line sensors, like the SCC and colour of the milk. Furthermore, AMS is quarter based, this prevents the spread of mastitis between teats of the same cow, and the teat cups can be cleaned between cows. The cows can be milked more than twice a day. Farmers using an AMS, rely on the machine to identify cows with abnormal milk production because the farmer is not controlling the milking progress itself. The system obtains information about the electrical conductivity, the temperature of the milk and the milk production. This data is used for information about the udder health. When abnormalities are found, the cows are put on an alert list. The farmer uses these lists for further decisions, whether or not to check and to treat the cows. Some of the alerts turn out to be false which can cause trust issues in the milking system and the mastitis alert lists, resulting in an improper use of the mastitis alert list (28-32).

To our knowledge, the variation in treatment of clinical mastitis between AMS and CMS farmers has never been described before. Although farmers differ in their approach towards treating clinical mastitis. The treatment policy may affect the mastitis situation on the farm, as reflected in the number of high SCC cows, number of new high SCC cows and incidents of clinical mastitis cases. As AMS farmers are increasing in number, it is important to know how their attitude towards treating cases of clinical mastitis on farms differs from CMS farmers and what the consequences are with respect to mastitis and antimicrobial use (AMU).

The aim of this study is to describe variation in treatment policy between AMS and CMS farmers, and identify associations between treatment policy, AMU and udder health on these farms.

Materials and Methods

The University Farm Animal Practice (ULP) did provide contact details for all CMS farmers in their practice (N = around 45), they were phoned to ask for participation. A random selection of AMS farmers from the same practice (N = around 45) were also contacted for participation. In total 44 farmers participated and gave their consent to use their Dairy Herd Improvement records (DHI records) for this study, consisting of 18 AMS farms, 24 CMS farms and two farms that are both AMS and CMS. The participating farmers were interviewed about their mastitis treatment policy by telephone, using a semi-structured questionnaire (Table 1).
For each farm, all data was collected through the ULP using the DHI records from each farm to collect data about the udder health and data about the milk -production and -quality on the farm. The antimicrobial use (AMU) of each farm is collected though a database special to registrate all the antimicrobial use of all cattle, which is designed to prevent resistance for antibiotics. The two farms which had both AMS and CMS as milking system were excluded because their data made no difference between the two milking systems they are using.

Table 1, Questions asked in the interview.

1	When is there clinical mastitis in a cow according to you?
2	Do you differentiate between different stages of clinical mastitis?
3	In which way do you discover cows with clinical mastitis?
4	Do you treat all animals with clinical mastitis?
4a	If not, witch cows do you treat?
5	What is your standard approach with clinical mastitis?
6	Witch medicine do you use?
7	How long do you treat the cows?
8	What is your alternative approach towards clinical mastitis?
9	Do you treat also cows with a high somatic cell count?
9a	When answered yes, what is your standard approach with subclinical mastitis?
10	Do you do bacteriological research before treatment of clinical mastitis?
10a	Why do you use bacteriological research? In which cases do you decide to do bacteriological research?
11	Do you do a follow up of the cows with clinical mastitis?
11a	Can you explain your approach?

All the relevant data extracted from the DHI records was put together in an excel sheet. The total amount of lactating cows, amount of dry cows, and the total amount of all cows present on the farm are recorded. Of each farm the BMSCC data was used from November 2016 till October 2017 to make sure all the data was comparable with each other. The SCC and BMSCC data were transferred to logarithm (with logarithm base 10) before statistical analyse.
The data about the AMU, obtained from the ULP, was also included in the excel sheet. For each farm the defined daily dose animal per year was given (ADD) (33), this is a quantification unit of antimicrobial consumption of each farm. It is assumed the average maintenance dose per day per kg bodyweight of a specific species. It also had information about which type of antibiotics where used, divided by first choice of antibiotics, second choice of antibiotics and third choice of antibiotics. Together with information about the antibiotic use special for mastitis incidence, antibiotics for dry cow treatment and antibiotics given by an injection.

The data from the interviews conducted by a research internship student, were put together in a different excel sheet. Some of the given answers had to be divided into sub questions, who could be only answered by yes and no, in order to analyse them.

Statistical analyse is used to compare the data between AMS and CMS farmers on different variables. At first a table was made of the data that had to be compared. A two sampled t-test is used to compare the data from DHI records between the AMS and CMS farmers. The Chi squared (Chi^2) test and the Fisher's exact test are used to compare the data from the interviews which were divided into categorical variables between the AMS and the CMS farmers. If the expected values in the table were <5, the chi squared test was used. If the expected values was >5 in the table, the Fisher's exact test was used. With these tests the p-value was calculated, which describes whether or not there is a significant difference ($p<0.05$) between the AMS and CMS farmers.

Results

From the total of 42 participating AMS (N = 18) and CMS (N = 24) farmers the answers to the interviews are divided into two tables. Information about how the farmers grade and detect clinical mastitis on their farm is shown in Table 2. This table shows the different opinion between AMS and CMS farmers about which clinical signs have to be present before calling it a clinical mastitis ($p<0.05$). AMS and CMS farmers also differs in their approach for the detection of clinical mastitis ($p<0.05$). All AMS (N = 18) farmers detect clinical mastitis from an AMS alert while all CMS (N = 24) farmers detect clinical mastitis while inspecting the cow during milking.

Table 2. Answers to the interview questions (Table 1) about detection and grading clinical mastitis. In total 42 Dutch dairy farmers participate, 18 farmers with an automatic milking system (AMS) and 24 farmers with a conventional milking system (CMS).

* = Chi^2 test

** = Fishers exact test

Question	Answers	AMS N (%)	CMS N (%)	p-value
Which clinical signs have to be present.	Abnormalities of the milk.	4 (22)	2 (8)	0.006**
	Abnormalities of the milk and udder.	4 (22)	17 (71)	
	Abnormalities of the milk, the udder and a systemic sick cow.	10 (56)	5 (21)	
Grading clinical mastitis.	Does not grade the clinical mastitis.	0 (0)	1 (4)	0.391**
	Grade 1[1], 2[2] and 3[3].	16 (89)	23 (96)	
	Grade 1[1] and 3[3].	1 (6)	0 (0)	
	Grade 3[3].	1 (6)	0 (0)	
Detect clinical mastitis.	AMS alert.	18 (100)	0 (0)	<0.001*
	Inspection cow[4].	1 (6)	24 (100)	<0.001*
	Somatic cell count.	1 (6)	1 (4)	1**
	Other[5].	5 (28)	11 (46)	0.580**

1 Grade 1, Mild, discoloured milk, milk can contains clumps, flakes, pus, blood or can be watery.

2 Grade 2, Moderate, abnormal milk and the infected quarter of the udder can be swollen, red, can have a higher temperature and can feel more firm.

3 Grade 3, Severe, abnormal milk, abnormal udder and the cow exhibited systemic signs of illness.

4 The farmer checks the cow during milking.

5 Other detection ways by farmers: Check filter of the milking machine or check the barn for cows with abnormal eating behaviour.

From the farmers who are using inspection of the cow to detect clinical mastitis (N = 25, AMS; 1, CMS; 24), 9 (38%) CMS farmers detect while fore striping, and 15 (63%) CMS farmers detect clinical mastitis during milking. The one AMS farmer did not give information about this.

From all AMS farmers (N = 18), 6 (33%) farmers check their AMS alert one time a day and 12 (67%) farmers check their AMS alert a few times a day. The farmers are using different types of alerts on their AM-system, 3 (17%) uses frequently visiting robot, 17 (97%) use electrical conductivity of the milk, 3 (17%) use abnormal colour of the milk, 7 (39%) use abnormal milk production, 2 (11%) use temperature of the milk and 4 (22%) indicate they use

SCC every third milking or attention list from the AMS alert to detect clinical mastitis. The farmers react differently towards the AMS alerts, 7 (39%) check all cows on the alert list, while 11 (61%) check only certain cows from the alert list, for example cows that show up on the list for the first time. Additionally, the farmer will check the milk for abnormalities, and if present, they will treat the cow accordingly.
Table 3 gives information from the interviews about the antibiotic use and treatment policy on the farms. What stands out is that there is no significant difference found between AMS and CMS farmers on the way they do: bacteriological research, treat cows with clinical and subclinical mastitis, the use of different types of antibiotics, the way they dose the antibiotics and how they will check on the cows who have been treated.

Table 3. Answers to the interview questions (Table 1), about antibiotic use and treatment policy. In total 42 Dutch dairy farmers participate, 18 farmers with an automatic milking system (AMS) and 24 farmers with a conventional milking system (CMS).
* = Chi^2 test
** = Fishers exact test

Question	Answers	AMS N (%)	CMS N (%)	p-value
Bacteriological research before treatment.	Yes.	2 (11)	1 (4)	0.691**
	Sometimes.	11 (61)	17 (71)	
	Never.	5 (28)	6 (25)	
All cows with clinical mastitis will be treated.	Yes.	5 (28)	9 (38)	0.741*
	No.	23 (72)	15 (63)	
Treatment pathway for antibiotics.	Treatment of the udder.	16 (89)	21 (88)	1**
	Treatment of the udder and intra muscular.	2 (11)	3 (13)	
Which kind of antibiotics does the farmer use for clinical mastitis.	Albiotic[1a].	0 (0)	2 (8)	0.498**
	Dofatrim[1b] (I.M.)	1 (6)	2 (8)	1**
	Ubrolexin[1c].	4 (22)	4 (17)	0.706**
	Avuloxil[1d].	10 (56)	11 (46)	0.755*
	Mamyzin[1e] (I.M.)	2 (11)	1 (4)	0.567**
	Orbenin Lactation[1f].	6 (33)	10 (42)	0.819*
Alternative treatment if the clinical mastitis is not healing properly after antibiotic treatment.	No information.	3 (17)	2 (8)	0.71**
	Use different 1st choice AB[2].	4 (22)	9 (38)	
	Use different 2nd choice AB[2].	8 (44)	10 (42)	
	Consult veterinarian.	3 (17)	3 (13)	
Use the antibiotic as the leaflet indicate[3].	No.	2 (12)	1 (4)	0.565**
	Yes.	15 (88)	22 (96)	
Farmer treat cows with a high SCC[4].	Yes.	10 (56)	13 (54)	1*
	No.	8 (44)	11 (46)	
Standard approach treating subclinical mastitis.	No information.	6 (33)	10 (42)	0.707**
	Uses different[5] AB[2] than with clinical mastitis.	1 (6)	2 (8)	
	Consult veterinarian, and do bacteriological research.	1 (6)	1 (4)	
	Uddermint.	2 (11)	1 (4)	
	Uses same AB[2] as with clinical mastitis.	5 (28)	9 (38)	
	Milk research.	3 (17)	1 (4)	
Farmer checks cows after being treated.	Yes.	14 (78)	21 (88)	0.438**
	No.	4 (22)	3 (13)	

1 Active substance:
Albiotic – lincomycin and neomycin.
Dofatrim (I.M.) - trimethoprim and sulfadoxine.
Ubrolexin - Cefalexin and Kanamycin.

Avuloxil - Amoxicillin trihydrate, Potassium clavulanate and Prednisolone.
Mamyzin (I.M.) - Penethamate hydroiodide.
Orbenin Lactation – Cloxacillin.

2 AB = antibiotic.

3 Farmers were asked how long they are using the antibiotic, and with what time interval. Their answers were checked if it was the same the leaflet indicated.

4 SCC = Somatic cell count.

5 1 AMS and 1 CMS using 1st choice AB[1] instead of 2nd choice AB. And 1 CMS farm is using a 2nd AB instead of 1st AB.

The main reason farmers perform bacteriological research is to know which types of bacteria are present on their farm causing the mastitis, but as shown in Table 3, it is not been done by all farmers. Some (N = 8) indicate they will do this if the mastitis incidence is higher as normal. Or when individual cows are not healing properly (N = 13). A few of the farmers (N = 4) will freeze a milk sample from the cow with mastitis and perform bacteriological research when the current treatment does not help.

Farmers who do not treat all cows with clinical mastitis (N = 38), will wait at first. In this period of time they make sure no milk is present in the infected udder, and they will treat the udder with uddermint. If there is no progress, they will start with antibiotics. If farmers detect many clots in the milk or if a cow has a fever they will start with antibiotic treatment directly. If cows are treated, the farmer can decide whether or not to check the cows if they are recovering. If the farmer decides to check the cow, it will be checked for about seven days after treatment. The AMS farmers (N = 14 (78%)) will check the electrical conductivity of the milk, check on the SCC of the cow or use uddermint. The CMS farmers (N = 21 (88%)) indicate they will check the DHI records (the information about the quality of the milk), frequently milk out the udder or using uddermint.

Table 4 shows the Dairy herd improvement records and the actual antibiotic use of the farms. No significant differences between AMS and CMS farmers were found. The BMSCC is calculated over one year (November 2016 - October 2017). Figure 1 shows the mean BMSCC per month for AMS and CMS farmers but no significant differences were found.

Table 4. Dairy herd improvement records, and antibiotic usage of the participating farms. In total 42 Dutch dairy farmers participate, 18 farmers with an automatic milking system (AMS) and 24 farmers with a conventional milking system (CMS).

Variable	AMS Mean±SD	CMS Mean±SD	p-value
BMSCC log[1] over one year[2].	5.22±0.16	5.20±0.13	0.587
Average farm SCC log[3] over one year[2].	5.21±0.14	5.23±0.15	0.736
Percentage off all lactating cows with SCC[3] above 200,000 cells/ml. Mean over one year[2].	18.48 (%)±6.1	17.65 (%)±6.26	0.679
Defined daily dose animal per year.	2.73±1.16	2.50±1.15	0.540
First choice of antibiotics.	2.14±0.94	1.88±0.97	0.383
Second choice of antibiotics.	0.58±0.36	0.62±0.38	0.728
Antibiotics used for mastitis cases.	0.67±0.37	0.80±0.44	0.301
Antibiotics used for dry cow treatment.	1.10±0.55	1.06±0.73	0.825
Antibiotics given by injection.	0.91±0.57	0.60±0.45	0.067

1 BMSCC = Bulk milk somatic cell count over one year.
2 One year from November 2016 - October 2017.
3 SCC = Somatic cell count.

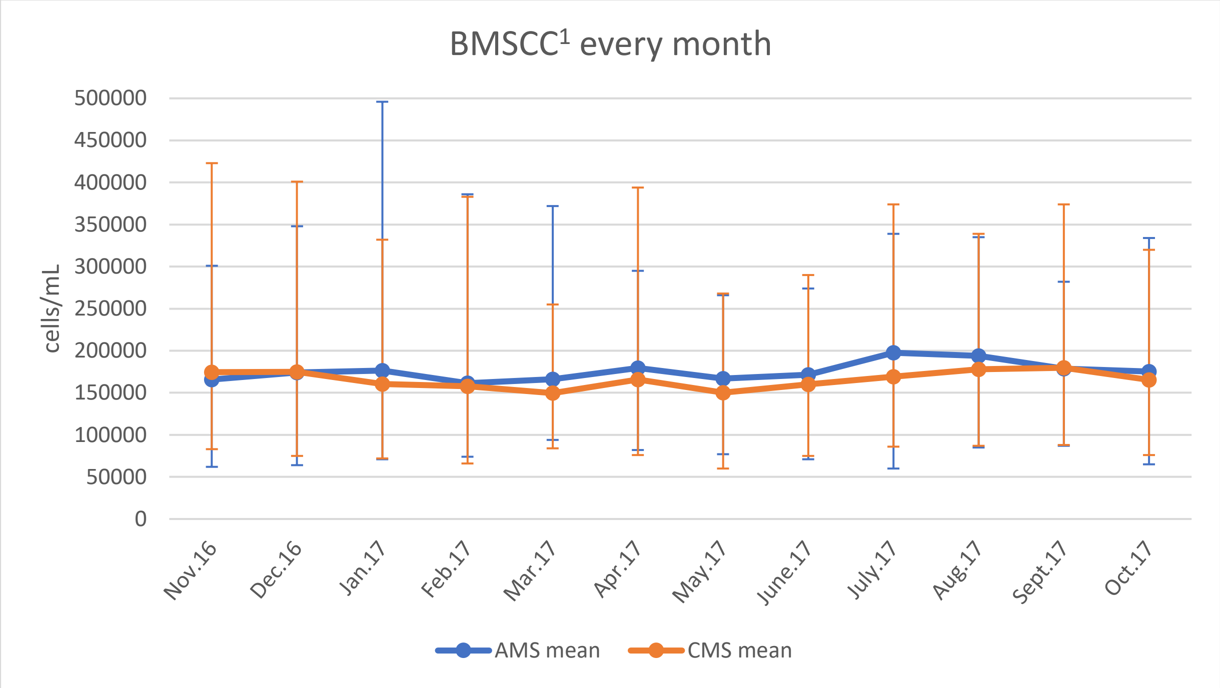

Figure 1.
1 BMSCC = Bulk milk somatic cell count

Discussion

The objective of this study was to describe the variation in treatment policy of clinical mastitis between AMS and CMS farmers, and to identify associations with AMU and udder health on these farms. The results show that AMS and CMS farms are remarkably similar in their treatment policy, AMU and mastitis situation. Still, AMS and CMS farmers differed in their definition of clinical mastitis and in how farmers diagnose clinical mastitis. AMS farmers logically detect clinical mastitis through the AMS alerts, as the farmer is not involved in the milking process. In contrast, CMS farmers detect clinical mastitis through inspection of the cow during milking Some of the farmers used also other ways to detect clinical mastitis (Table 2), but none of these were significantly different between AMS and CMS farmers. Clinical mastitis can be categorised into three stages: mild, moderate and severe (8). In grading the clinical mastitis, no significant difference was found between AMS and CMS farmers (Table 2). But AMS and CMS farmers differ in their opinion to where they draw the line on which signs have to be present to call it a clinical mastitis. Most of the AMS farmers required all three stages to be present, while CMS farmers only required stage 1 and 2 to call it a clinical mastitis. This difference between AMS and CMS farmers was significant ($p<0.05$). For farmers with cases of mild clinical mastitis, frequent milking, massage of the udder or the wait-and-see approach may be the initial choice of action. Perhaps they think only abnormalities of the milk on its own is not severe enough to call it a clinical mastitis (34) this could be the reason only 6 (N (AMS) = 4 (22%), N (CMS) = 2 (8%)) farmers chooses abnormalities of the milk as a sign of clinical mastitis (Table 2). The differences between AMS and CMS could be explained further, because AMS farmers do not see their cows while milking, clinical mastitis may go unnoticed when no specific mastitis diagnostic methods are used (35). For some of the true-cases of clinical mastitis no alert will be given, these cases will be later detected by the farmer or by the robot, when the signs are more severe. Dairy farmers working with an AMS from previous studies complaint about the relatively large number of false-positive alerts on the mastitis alert lists. It is difficult to decide which alerts have the highest priority to be visually checked, and due to lack of time, not all farmers do check all alerts in practice (36). For the detection of clinical mastitis by the AM-system it is important to identify at least those cows with a severe udder infection (30), that is why AMS farmers see more often a systemic sick cow with swollen udder and abnormal milk instead of only abnormal milk, when their AMS gives an alert. Another explanation for the difference could be that the exact definition of clinical mastitis may not have been the same between farmers. For the next time, after the question about the signs for clinical mastitis, it is helpful to tell the farmers the clear definition of a case of clinical mastitis prior to the rest of the interview (37).

Before treating clinical mastitis farmers can do bacteriological culturing to know which bacteria is causing the mastitis (1, 24, 25). According to Ouweltjes et al. (24) only a fraction (<3%) of the Dutch dairy farmers submit regularly milk sample, and it is not clear if the farms that do bacteriological research are comparable to the farms that do not bacteriological research in case of mastitis. In this study only 3 (7%) of the 42 participating farmers (2 AMS and 1 CMS) will always do bacteriological research before treatment. This small number of farmers submitted bacteriological research corresponds to Ouweltjes et al. (24), and could be explained by the related costs, the effort, and the time-to-result (38). Also it has been reported that from clinical mastitis cases 10 to 40% cultures yield no bacterial growth (2). Usually mastitis treatment decisions are made based on historic bacteriological culture results and treatment protocol (38). This corresponds with the results found in this study and no significant difference between AMS and CMS was found.

The most frequent reason for antibiotic usage in dairy cattle is treatment or prevention of clinical mastitis (2, 39). Most of the farmers (N = 38) in this study indicates not to treat all their cows with clinical mastitis as shown in Table 3, but between AMS and CMS farmers no significant difference was found. This is probably related to the wait-and-see approach, the threshold for action is not reached yet (34). In some situations applying antimicrobials is debatable. For example, between groups of dairy cows that were treated with or without antimicrobial agents there was no difference in the cure rates of mild clinical mastitis (38, 40, 41). The same is found for subclinical mastitis, where the outcome of antibiotic treatment depends on the duration and severity of the infection (42, 43). This corresponds with the results found in this study, almost half (N = 23) of the farmers will treat cows with high SCC, while the other half (N = 19) do not treat cows with high SCC (Table 3).
The BMSCC over one year (Table 4) between AMS and CMS farmers was not significant different. Data from the first AMS farms in the Netherlands showed a similar BMSCC before and after the introduction of the AMS (32, 44). This is similar to the results found in this study. But it also has been shown that a more frequent removal of milk could reduce the possibility for bacteria to adhere in the udder tissue. Which can result in a decrease in SCC at AMS farms (44, 45). On the other hand, an increased SCC can be found for AMS farms when they changes to an AMS system (45). The literature is conflicting on this point, so more research is needed.

The different types of antibiotics used to treat clinical mastitis between AMS and CMS farmers was not significant different. Each type of antibiotic was analysed separately. As shown in Table 3, most AMS and CMS farmers are using first choice cloxacillin (Orbenin lactation) and second choice amoxicillin (Avuloxil) to treat the cows with clinical mastitis. If the current antibiotic is not helping, they start with a different type of treatment (alternative treatment), but this was not significantly different between AMS and CMS farmers (Table 3). It is unclear when farmers will start or why they start with an alternative treatment, this was not asked in the interview. According to Fanny et al. (46) alternative treatment is treatment without antibiotics including homeopathy (46). In this study 74% (N = 31) of the farmers indicate they will use antibiotics as an alternative treatment, it is concluded that the definition was not clear. N = 4 AMS farmers (22%) and N = 9 CMS farmers (38%) switch from a second choice antibiotic to a first choice antibiotic, while N = 8 AMS farmers (44%) and N = 10 CMS farmers (42%) switch from a first choice antibiotic to a second choice antibiotic (Table 3). But no literature about switching antibiotics was found.
Only the farmers who had indicated that they will treat cows with high SCC (N = 23), were asked what their standard approach is for treating subclinical mastitis. Most of the farmers (N = 14) will use the same type of antibiotic as with the clinical mastitis as shown in Table 3. But no significant difference between AMS and CMS farmers was found. As shown in Table 3, all the farmers who indicated they do not treat cows with high SCC, did not have to answer the question about their standard approach for subclinical mastitis. No literature was available about the active substances of the antibiotics mentioned in this study.

The amount of antibiotics given by the veterinarian can be found by the defined daily dose animal per year (ADD), this is assumed the average maintenance dose per day per kg bodyweight of a specific species (cow). But there is no significant difference found between AMS and CMS farms (Table 4). Most Dutch dairy farmers have an average ADD between 2 and 3 over the years 2012 - 2015 (47). The farmers in this study correspond to those numbers. In the Netherlands, goals to reduce the antibiotic use in livestock are already been set. The preventive use of antibiotics is forbidden. As a result, antibiotics used for dry cow treatment have been introduced. This allows antibiotic use at drying off only in cows with intra mammary infections (39, 48). Between the AMS and CMS farmers no significant difference was found and over the years 2012 - 2015 an average of 1.2 dry cow treatment was found (47). The farmers in this study are using less dry cow antibiotics (AMS mean; 1.10 and CMS mean; 1.06).

All farmers (N = 42) administer the antibiotics intra mammary and some of them in addition treat intramuscular (N = 5), but it is not significant different between AMS and CMS farmers (Table 3). As shown in Table 3 six farmers are using antibiotics who have to be dosed intramuscular. One AMS farm did not choose for intramuscular treatment, perhaps he did not knew or he is using the wrong dose. Almost all farmers say that they are using the antibiotics as the package leaflet indicates. A few farmers (N = 3) do not use the antibiotic the way they should. Are they using the antibiotic the wrong way, or did they said it wrong during the interview. To know for sure if they dosed it wrong or they only said they are using the antibiotic wrong, the question should be asked again and checked again.
Most of the farmers will keep track of the cow after the treatment. Only a few do not check up on the treated cow. But there is no difference between AMS and CMS farms found. Most of the farmers will take seven days to check the cow if it is recovering well, no literature was found for comparison.

The weaknesses of this study:
For the questions asked in the interview about which clinical signs have to be present and about the alternative treatment of clinical mastitis the definition was probably not entirely the same among farmers. For further research it is necessary to tell the farmers the correct definition before continuing the rest of the interview.
Response Bias, the farmer may give the response that they think the interviewer wants to hear. For example, the dose and interval for the antibiotic treatment may have been exactly what is written in the treatment protocol of the farm, instead of the actual usage of the antibiotic, this could affect the results of this study about the treatment protocol of the farmers. But we could assume the farmers will check the leaflet of the antibiotic before treating the cow if there is any doubt. Confounding Bias, for this study the herd size of the farmers was not taken into account, but the mean number of cows between AMS and CMS farmers was not significant different (results not shown). Also the clinical mastitis incidence rate could not be calculated, because the farmers did not track all their mastitis cases over the past year, for the results of this study it was not essential but it could give extra insights. Perhaps the total amount of participating farmers was too small to find any differences between AMS and CMS farmers, for next studies a bigger population is recommended.

Conclusion

This study was conducted to describe variation in treatment policy between AMS and CMS farmers. The most significant difference between the two milking systems are about which clinical signs have to be present to call it a clinical mastitis, and the way AMS and CMS farmers detect cases of clinical mastitis. Of all the antimicrobial use on the farms no differences were found, so there are no changes necessary in this area. The detection of clinical mastitis by AMS farmers could perhaps be improved, the AMS farmers have in comparison to CMS farmers more time to check cows on the AMS alert list. The participating AMS farmers indicate they do not check all the cows on the alert list. More research is needed in the different decisions between AMS and CMS farmers, and their personalities and attitude towards mastitis on their farm. About the BMSCC between AMS and CMS farmers the literature was conflicting, also more research could be done to learn more. About the active substance in antibiotics used in this study no literature was available, so this is something for further research in the future.

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