Selective dry cow therapy

The MPR as a tool to predict the production and somatic cell count

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Abstract

The aim of this study is to determine if the most recent Milk production registration (MPR) can use as a selection criteria for drying off with or without antibiotics.
The cows that participated in this study are cows from the study 'Selective dry cow therapy'. In this study 137 cows from 27 Dutch dairy farms are sampled. The cows that participate in this study were selected on somatic cell count (SCC), only heifers with a SCC of <150,000 cells/ml or cows with a SCC of <250,000 cells/ml on the most recent MPR were included. Quarter samples of the cows were collected aseptic for SCC and bacteriological analyses.
After a regression analysis, the production at T_{MPR} is associated with the production at T_{dry}. The days between T_{MPR} and T_{dry} are not associated with the production at T_{dry}.
The SCC at T_{MPR} is associated with the SCC at T_{dry}. The production at T_{dry} is also associated with the SCC at T_{dry}. The days between T_{MPR} and T_{dry} is not associated with the SCC at T_{dry}.
After these first analyses, it was analysed where categories are made from the amount of days between T_{MPR} and T_{dry}. These are divided per two weeks. The first analysis is from day 0 till 14 days between T_{MPR} and T_{dry}, the next from 15 till 28 days and the latest from more than 28 days between T_{MPR} and T_{dry}. When the data was split into categories of two weeks the R^2 was changed. The R^2 was much higher in the period 0-14 days than in the other periods.
This was followed by an analysis with the highest quarter SCC in combination with the SCC at T_{MPR}. There was a link between the SCC at T_{MPR} and the SCC at T_{dry}. Between the production at T_{dry} and the SCC at T_{dry} there was a link as well. This analysis showed that there was no link between the SSC at T_{dry} and the number of days between T_{MPR} and T_{dry}.
Of 137 cows with a SCC less than 250,000 cells/ml on the most recent MPR, is viewed how many quarters had a SCC of ≥250,000 cells/ml on T_{dry}. With the adjusted Wald Method the confidence interval (95%) is calculated.
The MPR is not a good tool to predict the production at T_{dry}.
The dairy farmer could use the MPR for selective dry cow therapy provided that, it is not older than two weeks. When the MPR is older than two weeks, it is better for look for another tool. This could be the CMT, or maybe it is necessary to determine the SCC again. The more time between T_{MPR} and T_{dry}, the chance on a new intramammary infection is higher.

Introduction

Mastitis causes great economic losses to the dairy industry through costs of treatment, decreased production, extra labor and increased cow replacement rates (Schepers *et al.*, 1997). Worldwide, the economic losses of clinical mastitis range from 61 to 97 euro per cow. In the Netherlands, the losses vary between 17 and 198 euro per cow per year due to clinical and subclinical mastitis (Hogeveen *et al.*, 2011).

The dry period in the dairy cow is a period where the cow is sensitive for the occurrence of new intramammary infections (IMI) (Robert *et al.*, 2006). Dry cow therapy has two objectives. First, eliminating existing IMI present at drying off and preventing new IMI during the dry period and around calving (Halasa *et al.*, 2009).

Antibiotics for dry cow management have long been recommended to prevent mastitis. In the Netherlands, 87 per cent of the dairy farmers use antibiotics for dry cow management. The total use of antibiotics for dry cow management is 38 per cent in the Dutch dairy industry (Breekman, 2010).
The use of antibiotics for dry cow therapy is complicated nowadays for several reasons: the risk of antibiotic resistance and antibiotic residues in milk; the treatment of uninfected quarters and the reduction of the prevalence of IMI due to contagious pathogens (Robert *et al.*, 2006).
The objective of the Dutch dairy sector is to reduce the antibiotics in 2013 with 50 per cent. To reduce the use of antibiotics a more selective use of dry cow therapy is necessary. For successful selective dry cow management it is important to know at which somatic cell count (SCC) the farmer does not need to use dry cow therapy (Breekman, 2010). The GD Animal Health Service (GD AHS) started a study to develop selection criteria based on herd-, cow, and quarter factors to determine which cows could dry off without preventive treatment of antibiotics, without an unacceptable increase of subclinical and clinical mastitis in the dry-off period or in early lactation. The aim of this study was responsibility to decrease dry cow therapy with antibiotics, which will decrease the total use of antibiotics in the dairy industry. During this study, it will be considered if dry cow therapy is always necessary. Maybe it is possible to use only antibiotics at a high somatic cell count (SCC).
A potential tool for selective dry cow therapy could be the SCC of the last Milk Production Registration (MPR) or the California Mastitis Test (CMT).
The CMT was first described in 1957 (Schalm and Noorlander, 1957). It is a test which can be performed fast and cow-side. The test was developed to test milk from separate quarters, but can also be used for composite cow milk (Sanford *et al.*, 2006).

In a healthy lactating mammary gland, SCC is often less than 10^5 cells/ml of milk (Sordillo et al., 1997). Research has shown that uninfected quarters have a mean SCC of about 70,000 cells/ml (Schukken *et al.*, 2003). During a bacterial IMI, the SCC can increase to more than 10^6 cells/ml of milk within just a few hours, depending on the bacteria involved (Sordillo *et*

al., 1997). Therefore SCC is often used to differentiate between bacteriologically infected and uninfected quarters (Schukken *et al.*, 2003).

Somatic cell count

Somatic cells are mostly cells of the immune system (80% in uninfected quarters, 99% in mastitic quarters) (Sordillo *et al.*, 1997). The SCC includes all types of cells in milk. The cell types are macrophages, neutrophils, eosinophils, lymphocytes and various epithelial cells of the mammary gland (Kehrli and Shuster, 1994). Somatic cells are therefore a reflection of the inflammatory response to an IMI or another trigger of the immune system (Schukken *et al.*, 2003). Uninfected milk contains mainly macrophages (60%) and lymphocytes (28%) and a few polymorphonuclear leucocytes (PMN) (5-12%). In mastitic quarters, the percentage of PMN increases considerably (up to 90%) (Pillai *et al.*, 2001).
Schepers *et al.* (1997) made an analysis of the effects on SCC. They have looked at factors concerning herd-level, cow-level, within herd, month of sampling, quarter, stage of lactation, parity, interaction between stage of lactation and infection status. The SCC was high at the start of lactation (Figure 1). During the first 10 days after calving SCC decreased rapidly to a minimum on day 40 postpartum until day 80 postpartum. After day 80 postpartum SCC steadily increased until the end of lactation. The shapes of these curves indicated a possible effect of dilution. Within a lactation, the SCC of uninfected cows is influenced by the amount of milk production (Schepers *et al.*, 1997). This means that if the production decrease the SCC increase.

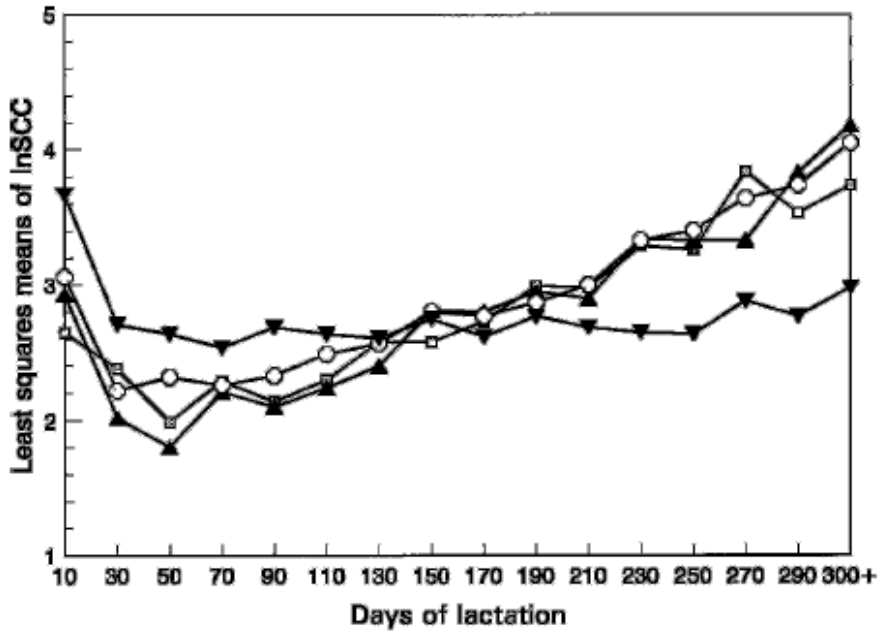

Figure 1: Interactive effects of days of lactation and parity (Schepers *et al.*, 1997)
(Parity 1: down triangle, parity 2: octagon, parity 3: up triangle and parity >3: square).

The difference in the shape of the lactation curve for logarithm SCC was significant among parities. The curve was relatively flat for first lactation cows. For cows in lactation > 1, the curve increases more to the end (Schepers *et al.*, 1997).

In the study of Schepers *et al.* (1997), they could explain 50% of the variation in logarithm SCC. The most predominant factor was infection status. Cow and stage of lactation explained more than 5% of the variation in logarithm SCC. It was also shown that the mean SCC of uninfected quarters increased with age and decreasing milk production.

When a cow gets a bacterial infection in the udder, a resting population of white blood cells gets a signal that induces a massive influx of mostly PMN in the milk (Burvenich *et al.*, 1994). The PMN will kill the bacteria and eliminate the infection. Usually, within a few weeks SCC will return to normal levels (Figure 2). This is specific on *Escherichia coli* infections (van Werven *et al*, 1997).

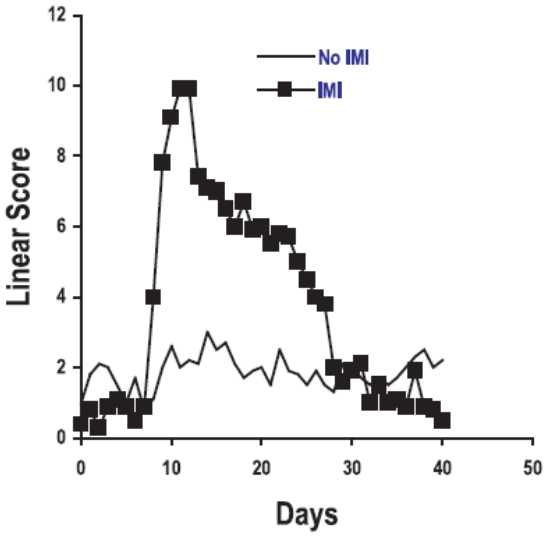

Figure 2: Somatic cell count pattern during a successful immune response to an incoming *E.coli* infection. A non-infected contra lateral quarter is shown to represent non-infected quarters (Schukken *et al.*, 2003. Data from van Werven *et al.*, 1997).

When the immune system is not able to remove the bacteria the infection results in a chronic infection with an elevated SCC for a longer time (Harmon, 1994).
Figure 3 shows the SCC of a chronic *E. coli* infection. There is always a fluctuation in cell counts, however, most of the time the SCC is above the previously defined cut-off for uninfected quarters (Schukken *et al.*, 2003).

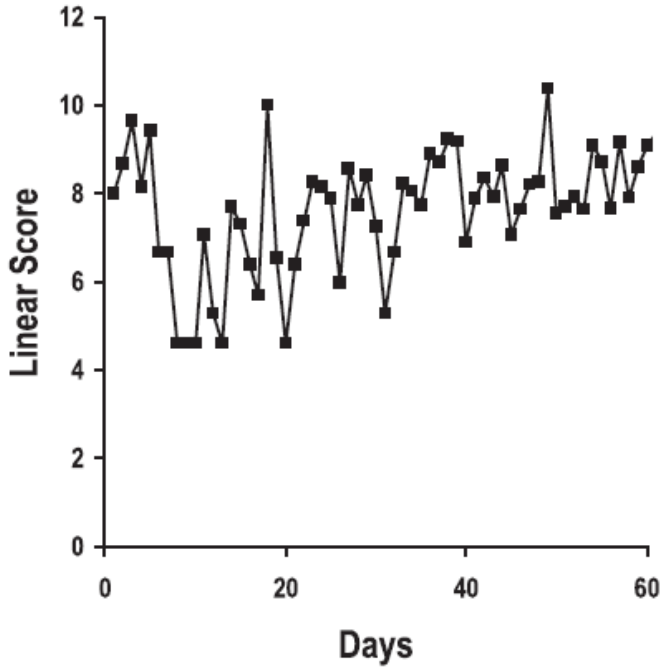

Figure 3: Somatic cell count pattern of a quarter chronically infected with *E.coli* (Schukken *et al.*, 2003. Data from Döpfer, 2000).

Somatic cell counts are usually measured in composite cow milk. It is particularly important to characterize the relationship between presence of an IMI with the cell count response of the cow in composite milk. Knowledge of this relationship will enable inferences about IMI prevalence, from SCC data.

The most accurate relationship between IMI and SCC exist at quarter level. Cow composite samples of SCC and IMI are a composite of four quarters with dependent but separate infection status and inflammatory response. Most dairy producers have only access to cow composite information on MPR. Therefore, the relationship between these two parameters is of great practical importance (Schukken *et al.*, 2003).
Because the most dairy farmers only know the SCC of the MPR, this could be a good tool for selective dry cow therapy. The most dairy farmers are participant of MPR so it gives no extra labour or costs.

Aim of the study

The aim of this study is to determine if the most recent MPR can use as a selection criteria for drying off with or without antibiotics.

Materials and Methods

Herd and cow selection

The cows that participated in this study are cows from the study 'Selective dry cow therapy', sampled between 23 May 2011 and 29 June 2011 and which the MPR data is delivered by the dairy farmers. In this study 137 cows from 27 Dutch dairy farms are sampled. Participation to this study was voluntarily. One condition was that the dairy farmers were participant of the MPR and had more than 40 cows. The dairy farms had the possibility to sign in, after this they were called for an appointment. The cows that participate in this study were selected on SCC. In this study only heifers with a SCC of <150,000 cells/ml or cows with a SCC of <250,000 cells/ml on the most recent MPR were included.
Cows with a SCC above this cut-off value have a bigger chance to have a subclinical infection (Smith, 1996) and could threat with antibiotics at drying-off. Sick animals (with clinical symptoms) or animals under antibiotic treatment, dairy cows with a teat or a teat opening damage and cows with less than four lactating quarters were excluded for research.

Protocol

The dairy farms were visited every two weeks on average. One or more animals that had to be dried-off (6-8 weeks before expected parturition) were collected. The cows were investigated in the milking parlor, the robot or at the feed fence. The researchers were wearing gloves and made the udder clean with a dry towel. Every teat was stripped 3 times. Before the samples were taken, the CMT was done. After the teat was disinfected with cotton and alcohol 70% (aseptic), quarter milk samples were taken in a plastic tube for SCC and bacteriological analyses. The samples were transported in a cooler box containing cooling blocks and were delivered at the 'Veterinair diagnostisch laboratorium' of the GD AHS in Deventer. Then the samples were sent to 'Qlip' in Zutphen for culture and the SCC was determined by a Fossomatic.
The data of the most recent MPR was obtained by the dairy farmers. Data of the MPR that was used included: date of the control, the production and the SCC at this time (T_{MPR}). The data was compared with the production and the SCC at dry-off (T_{dry}).

Statistical analysis

The data was analysed using IBM SPSS Statistics 19. The outcome variable (production) was checked to see if it was distributed normally and a scatterplot was used to view if there was a linear relation expected between production on the moment of sampling of the MPR (T_{MPR}) and the moment of drying off (T_{dry}). Afterwards, a regression analysis was done.
The model for the production on T_{dry} was as follows:

$$\text{Production} = \beta_0 + \beta_1 \text{MPR} + \beta_2 \text{days between} + \varepsilon.$$

The production is the dependent/outcome variable, β_0 the intercept, β_1 is the regression coefficient for the production at T_{MPR}, β_2 is the regression coefficient for days between T_{MPR}

and T_{dry} and ε is the error. The variables were first tested in uni-variable models and later combined into one multivariable model.

The SCC was transformed in natural logarithmic numbers to obtain a normal distribution (Ali and Shook, 1980).
Outcome variable (SCC) was checked to see if it was normally distributed and with a scatterplot was viewed if there was a linear relation to be expected between SCC at (T_{MPR}) and (T_{dry}). Then a regression analysis was done.
The model for the SCC at T_{dry} was as follows:

$LnSCC = \beta_0 + \beta_1 production\ dry\ off + \beta_2 MPR + \beta_3 days\ between + \varepsilon$
The natural log of SCC is the dependent/outcome variable, β_0 the intercept, β_1 is the regression coefficient for the production on T_{dry}, β_2 is the regression coefficient for SCC at T_{MPR}, β_3 is the regression coefficient for days between T_{MPR} and T_{dry} and ε is the error. The variables were first tested in uni-variable models and then combined in one multivariable model.

After these first analyses, it was analysed where categories are made from the amount of days between T_{MPR} and T_{dry}. These are divided per two weeks. The first analysis is from day 0 till 14 days between T_{MPR} and T_{dry}, the next from 15 till 28 days and the latest from more than 28 days between T_{MPR} and T_{dry}.
This was followed by an analysis with the highest quarter SCC in combination with the SCC at T_{MPR}. The same analyses were done as with mean SCC.

Of 137 cows with a SCC less than 250,000 cells/ml on the most recent MPR, is viewed how many quarters had a SCC of ≥250,000 cells/ml on T_{dry}.
With the adjusted Wald Method the confidence interval (95%) is calculated.

Results

Descriptive

In total 137 cows were involved in the research variating from 27 farms. Of 8 cows (6%) the production at T_{dry} unknown. The avarage production at T_{MPR} was 19.0 kg (95%CI: 18.2 – 19.9). The avarage production at T_{dry} was 12.0 kg (95%CI: 11.0 – 13.1).
The mean SCC at T_{MPR} was 79,000 cells/ml (95%CI: 71,000 – 89,000 cells/ml). The mean SCC of the cows was 206,000 cells/ml at T_{dry} (95% CI: 167,000 – 253,000 cells/ml).

Production

The production at T_{MPR} is associated with the production at T_{dry} ($p < 0.01$; Figure 4).
The production at T_{MPR} reveals for a very limited part the variance in the production at T_{dry} (R^2=0.13). The days between T_{MPR} and T_{dry} are not associated with the production at T_{dry} ($p = 0.83$).
Using the analysis the next regression equation is made.

Production at T_{dry} = 4.382 + 0.415 x production T_{MPR}.

The analysis shows that if the production at T_{MPR} is higher than 7.5, the production at T_{dry} is lower. If the production at T_{MPR} is lower than 7.5, the production at T_{dy} would be higher than the production at T_{MPR}.

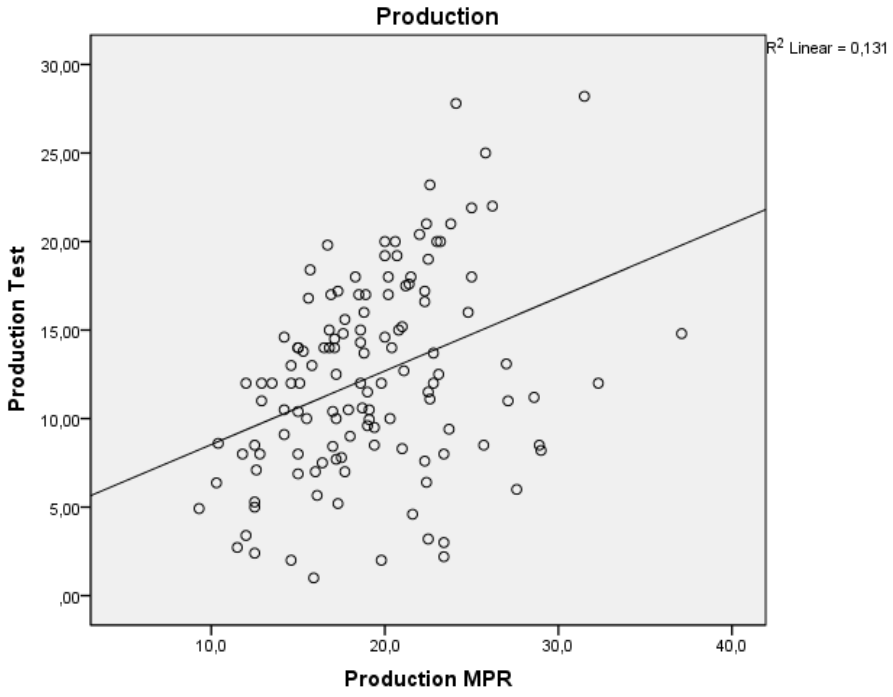

Figure 4: Scatterplot production at T_{MPR} and T_{dry}.

Somatic cell count

The SCC at T_{MPR} is associated with the SCC at T_{dry} ($p<0.01$; Figure 5; Table 1). The production at T_{dry} is also associated with the SCC at T_{dry} ($p<0.01$; Figure 5; Table 1).
The days between T_{MPR} and T_{dry} is not associated with the SCC at T_{dry} ($p = 0.995$)

The SCC at T_{MPR} and the production at T_{dry} for all the periods explain mainly the variance in the SCC at T_{dry} ($R^2=0.44$; Table 1).
When the data was split into categories of two weeks the R^2 was changed.
The SCC at T_{MPR} and the production at T_{dry} for the period of 0-14 days after T_{MPR} explain the variance in the SCC for a bigger part at T_{dry} ($R^2=0.66$; Table 1).
The SCC at T_{MPR} and the production at T_{dry} for the perid of 15-28 days after T_{MPR} explain for a limited part the variance in the SCC at T_{dry} ($R^2=0.35$; Table 1).
The SCC at T_{MPR} and the production at T_{dry} for the period >28 days after T_{MPR} explain for a limited part the variance in the SCC at T_{dry} ($R^2=0.42$; Table 1).

Table 1: Regression analysis with SCC at T_{MPR} and production at T_{dry}.

	R^2	**N**	**B**	**p**
0-14 days		33		
- Production test			-0,073	0,000
- SCC MPR	0,660		0,915	0,000
15-28 days		49		
- Production test			-0,077	0,007
- SCC MPR	0,346		0,768	0,002
>28 days		55		
- Production test			-0,086	0,001
- SCC MPR	0,417		0,736	0,000
Total		137		
- Production test			-0,079	0,000
- SCC MPR	0,439		0,797	0,000

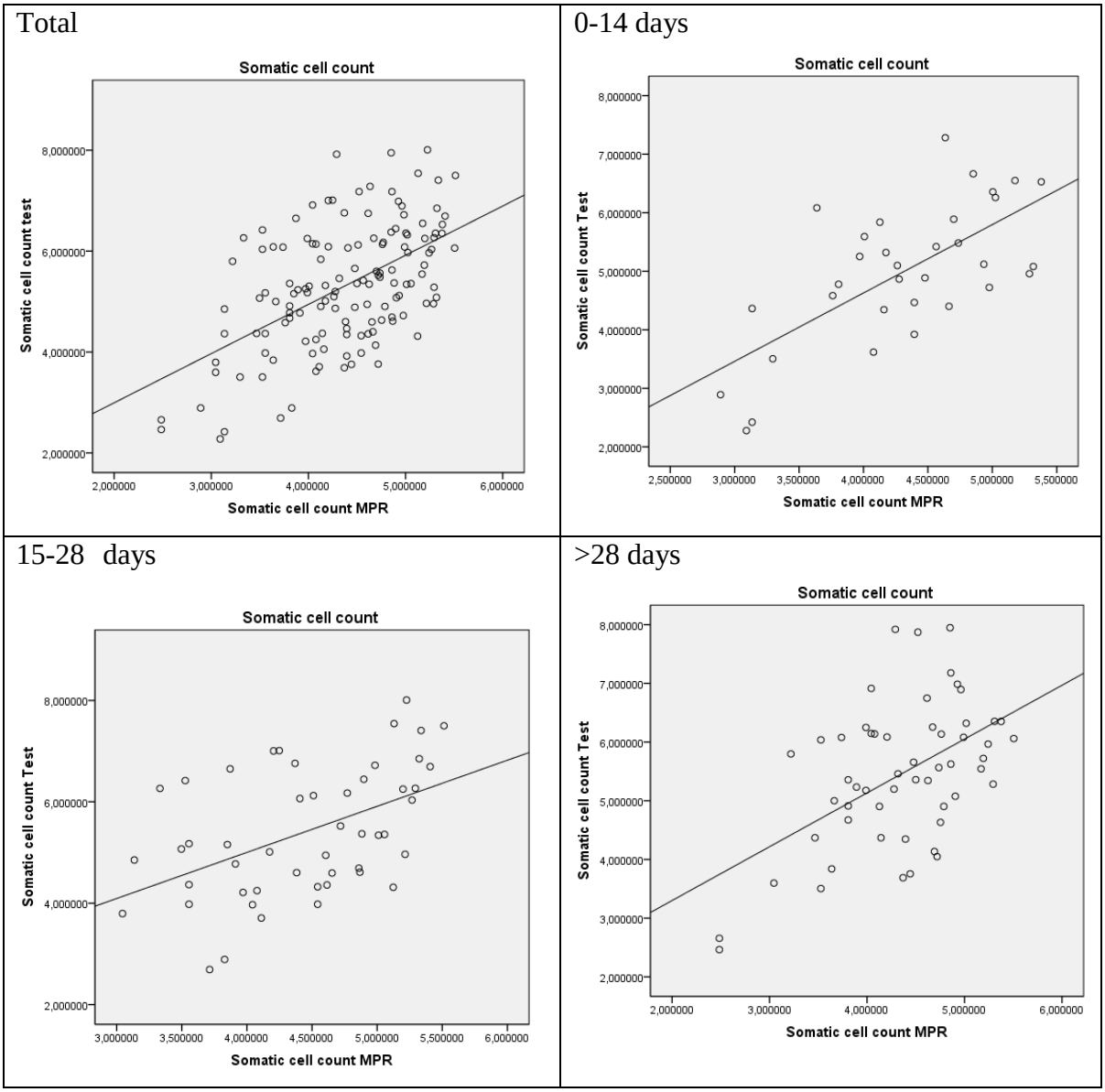

Figure 5: Scatterplots SCC at T_{MPR} and mean SCC at T_{dry} with different periods between T_{MPR} and T_{dry}.

As with the analysis of the highest quarter SCC, there was a link between the SCC at T_{MPR} and the SCC at T_{dry} ($p<0.01$; Figure 6). Between the production at T_{dry} and the SCC at T_{dry} there was a link as well. This analysis showed that there was no link between the SSC at T_{dry} and the number of days between T_{MPR} and T_{dry} ($p=0.981$). The SCC at T_{MPR} and the production at T_{dry} explain the variance for a limited part of the highest quarter SCC at T_{dry} ($R^2=0.40$).
The regression equation below is composed using this analysis.

$$\text{Ln(SCC on } T_{dry}) = 2.993 + 0.863 \text{ x SCC } T_{MPR} - 0.073 \text{ x production } T_{dry}.$$

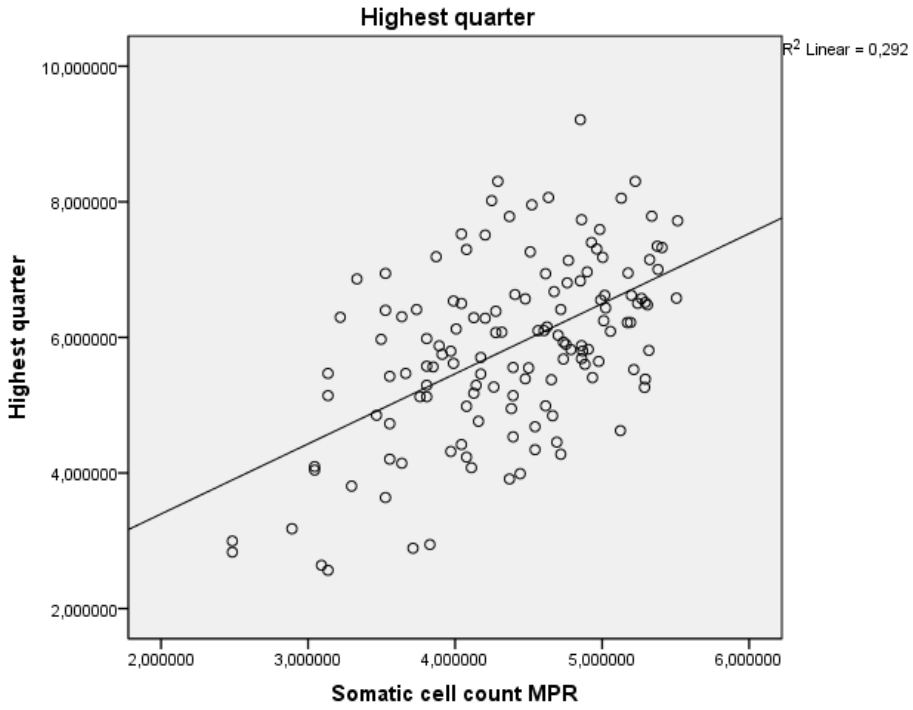

Figure 6: Scatterplot highest SCC at T_{dry} with SCC at T_{MPR}.

Out of the 137 cows which had a SCC of less than 250,000 at T_{MPR} is viewed how many quarters had a SCC of ≥250,000 at T_{dry}. Out of the 137 cows 36% (95%CI: 28-44%) had no quarter with a SCC ≥ 250,000.
Out of the 137 cows 23% (95%CI: 17-31%) had one quarter with a SCC ≥ 250,000, 9% (95%CI: 5-15%) of the cows had two quarters with a SCC ≥ 250,000 cells/ml and 12% (95%CI: 7-18%) had three quarters with a SCC of ≥ 250,000.
Out of the 137 cows 20% (95%CI: 14-28%) had four quarters with a SCC ≥ 250,000 at T_{dry} (Table 2).

Table 2: Cows with quarters with a SCC of ≥250,000 at T_{dry}.

Number of quarters with a SCC ≥250.000	**Number of cows (%)**	**Low**	**High**	**Best estimate**
0	49 (36%)	0.2822	0.4409	0.3597
1	32 (23%)	0.1702	0.3115	0.2374
2	12 (9%)	0.0496	0.1481	0.0935
3	16 (12%)	0.0722	0.1823	0.1223
4	28 (20%)	0.1449	0.2800	0.2086

Discussion

Production

The normal production curve of a dairy cow increases quickly after the parturition with a peak between 30 and 60 days and slows down after (Figure 7).

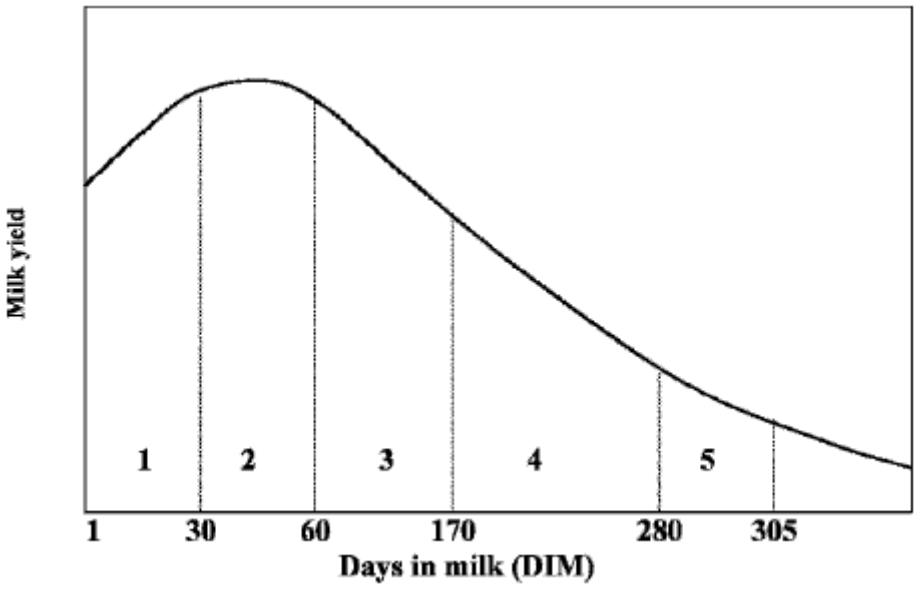

Figure 7. Partition of lactation curve into stages.
A lactation period of 305 d was partitioned into five stages. The ranges of the five stages are as follows: stage 1 (DIM 1-30), stage 2 (DIM 31-60), stage 3 (DIM 61-170), stage 4 (DIM 171-280), and stage 5 (DIM 281- 305) (Togashi and Lin, 2003).

It is expected that the production at T_{dry} lower is than at T_{MPR}. The analysis shows that this is with the formula if the production at T_{MPR} is higher than 7.5 kg. When the production at T_{MPR} is lower than 7.5, the production at T_{dry} is more than at T_{MPR}.
There was only one cow with a production less than 7.5 kg. This cow had a production of 4.7 kg at T_{MPR} and 19.8 at T_{dry}. It is possible that this is a mistake in sampling or maybe the cow was sick at T_{MPR}. This cow and the 8 cows which the production was unknown at T_{dry} are excluded of this analysis.

The analysis shows that there was clearly a connection between the production at T_{MPR} and T_{dry}, but the production is to predict for 8% (13%) with the production at T_{MPR}.
The biggest part of the production at T_{dry} could be explain by other factors.

The production at T_{dry} is read of the milk glass or –meters, taken out of the computer or estimate by the dairy farmer so that the production at T_{dry} is not totally reliable.
The milk meters could have a small deviation en the reading from the milk glasses is not exactly. In some cases the milk glasses hung askew, so it is difficult to read exactly.

The decrease production is partly dependent of the management. The 27 farms that are used in this analysis, used different methods to drying off. Some of the farmers are milking the cows once-daily. Some cows are shortly before drying off separated and get an energy low ration. These measures could reduce the production (Patton *et al*., 2006).

Somatic cell count

In this study we found a lot of cows with one or more quarters with a SCC above 250.000 cells/ml. There are a lot of factors that can influence SCC.
The most import factor affecting the SCC is the infection status (Dohoo and Meek, 1982). In this study there are a few quarters where found pathogens, but most of the time there is not found a pathogen with bacteriological research. The high SCC must be explained through other factors.
Many authors found an increase of the SCC of cows with increasing age. This increase is not per se increase per age, but the prevalence of infection in older cows is higher than in younger cows. This increase is perhaps a result of a higher prevalence of permanent glandular damage from previous infections in older cows (Dohoo and Meek, 1982).
At the end of the lactation, the production decrease. Especially when the farmers take measures to reduce the production. When the production decrease this could leads for an increase of the SCC (Renaue, 1986). This indicated a possible effect of dilution. Within a lactation, the SCC of uninfected cows is influenced by the amount of milk production (Schepers *et al.*, 1997). The production at T_{dry} is associated with the SCC at T_{dry}, but the production has no influence on the infection status and so not determines if there is use of antibiotics.
Somatic cell counts in quarter milk samples changed considerably during the day (Olde Riekerink *et al*., 2007). Olde Riekerink *et al.* (2007) found that postmilking SCC was much higher than pre-a.m. SCC. Cell counts are reported to be highest in the strippings or immediately after milking with these levels persisting for up to four hours before gradually declining to their lowest level which occurs immediately before the following milking. Somatic cell counts have also been reported to be lower in samples collected in the morning comparison to the evening milking (Dohoo and Meek, 1982). In this study some cows were sampled short after milking. The SCC of this cows should be higher than cows sampled before milking. The cows were all sampling on different times. Some of them were sampled in the morning, some in the afternoon and some in the evening.
Another factor could be day-to-day variation. Syrstad (1978) found that the average coefficient of variation in composite samples taken repeatedly over a short period of time to be approximately 30-35%.
The cows were sampled in the period 23-5-2011 till 29-6-2011. There is known that SCC are lowest during the winter and highest during the summer. Salsberg *et al*. (1984) reported that SCC increases from May till September and decrease in October. This year the months, April, May and June had high temperatures what can cause a higher SCC.

This analyse shows a relation between the SCC at T_{MPR} and T_{dry}. The results shows that the SCC two weeks after T_{MPR} is to predict for 66% with the production at T_{dry} and the SCC at

T_{MPR}. Between two and four weeks the predictability decrease to 35%. The MPR is till two weeks before drying off a good predictor. When the SCC at T_{MPR} increases, the SCC at T_{dry} increases too.

In the analysis there is looked to difference between farms. This difference is very small, so it has no influence on the results. The groups are small, so the reliability of the study was reduced.

Conclusion

The MPR is not a good tool to predict the production at T_{dry}.
The dairy farmer could use the MPR for selective dry cow therapy provided that, it is not older than two weeks. When the MPR is older than two weeks, it is better for look for another tool. This could be the CMT, or maybe it is necessary to determine the SCC again. The more time between T_{MPR} and T_{dry}, the chance on a new IMI is higher.

Acknowledgement

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