

# Control Chart Monitoring Provides Dynamic Measure of Herd Mastitis Prevalence

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Bulk tank somatic cell count (BTSCC) level depends on the prevalence of mastitis infection and the rate of new infections (NIR) among cows being milked into the bulk tank. The capability of the processes that control BTSCC to meet any specified SCC target will depend on how herd management affects the dynamics of these factors. Currently, mastitis prevalence and new infection rates are estimates derived from monthly individual cow DHI SCC testing. Monthly individual cow SCC testing is very important for identifying newly infected as well as chronically infected problem cows. However, more frequent measures of mastitis prevalence and new infection rate would provide herd managers with a more timely awareness of emerging mastitis and milk quality trends. However, the expense and disruption that would be caused by daily sampling of individual cows would be impractical.

Statistical process control (SPC) chart monitoring is now emerging as an effective means of measuring the day-to-day success (or failure) of milk quality and mastitis control programs. Recent research has shown that SPC capability indices are accurate and dependable sentinel measures of herd subclinical mastitis prevalence. At present, more research needs to be completed to determine if SPC capability indices (Cpk index) can also serve as accurate estimates of new infection rates.

The objective of this study was to determine if SPC ability indexes could be adapted as effective milk quality and mastitis monitoring tools for daily herd management decisions.

## Materials and Methods

Two data sets were used to examine the relationship between the bulk tank SCC and the prevalence of subclinical mastitis in the herd. Data set 1 contained BTSCC data collected daily or every other day for 6 months (January through June) from 694 Minnesota dairies. Data set 2 contained the information on the prevalence of sub clinical mastitis of 272 herds on the Minnesota DHI program. Data from data set 1 were transformed using natural logarithm and used to calculate a Cpk index for each of the herds based on month six of bulk tank SCC. The mean of individual values and the average moving range was used to calculate the Cpk index following the formula:  $Cpk = (\ln(\text{standard}) - \text{mean}) / (3 * AmR / d_2)$ , where mean is the natural logarithm of average BTSCC calculated from individual values of BTSCC; AmR is the average moving range calculated from individual values of natural logarithm of BTSCC;  $d_2=1.13$  for group size  $n=2$ . Four different standards were used to calculate four different Cpk indexes. Cpk400 used the 400,000 SCC standard imposed in the EU. Cpk500 relates to the 500,000 SCC standard adopted in Canada. Cpk600 relates to the 600,000 SCC limit implemented in California while Cpk750 is based on the 750,000 SCC limit obligatory in other states.

The SM data (data set 2) were also transformed by natural logarithm and merged by farm name with the Cpk indexes of individual herds calculated from the herd bulk tank SCC data. Two hundred sixty-nine matching herds were found and data from those herds (data set 3) was used to examine the relationship between the calculated Cpk indexes and SM. One hundred eighty herds from dataset 3 were randomly selected, a linear regression model was applied and the

least squares method of STATISTIX used to describe the relationship between the four Cpk indexes and the SM in the herds. A similar procedure was followed to describe the relationship between the four Cpk indexes and NIR in the herds.

To validate the developed models, the SM values observed for the remaining 89 herds were compared with the SMe (estimated subclinical mastitis values) calculated from the four linear regression models developed. The linear models resulting from this comparison and corresponding R<sup>2</sup> were evaluated.

## Results and Conclusions

High R<sup>2</sup> values (Table 1) indicate a strong correlation between the BTSCC and herd's SM. According to equations in Table 1, the SM in herds that are able to meet the SCC standard (Cpk = 1), is less or equal to 26%, 30%, 34%, 38% for the 400,000, 500,000, 600,000 and 750,000 standard, respectively. The linear regression models developed (Table 1) show that the higher the SCC standard used to calculate the Cpk index, the lower the correlation (R<sup>2</sup>) between the SM and Cpk and between SM and SMe. The relatively low correlations (R<sup>2</sup>) between NIR and Cpk indexes (R<sup>2</sup>=0.34, 0.31, 0.28, 0.24 for NIR vs Cpk400, Cpk500, Cpk600 and Cpk750, respectively) indicate that the single DHI test day estimate of NIR was insufficient to accurately describe NIR dynamics. Future studies should try correlating Cpk with more frequent NIR estimates based on everyday individual cow SCC testing.

Table 1. Linear regression models relating the four Cpk indexes to herd's SM and the estimated subclinical mastitis values (SMe) values to the observed SM.

Predictor variable	Dependent variable	Constant <sup>4</sup>	Beta coefficient <sup>4</sup>	R <sup>2</sup>
Cpk400 <sup>1</sup>	lnSM <sup>3</sup>	-0.98353	-0.36106	0.6934
Cpk500 <sup>1</sup>	lnSM	-0.84377	-0.34555	0.6341
Cpk600 <sup>1</sup>	lnSM	-0.75305	-0.32102	0.5655
Cpk750 <sup>1</sup>	lnSM	-0.68032	-0.28135	0.4703
SMe400 <sup>2</sup>	SM	0.07531	0.74223	0.7823
SMe500 <sup>2</sup>	SM	0.09391	0.67700	0.7513
SMe600 <sup>2</sup>	SM	0.11649	0.60295	0.7019
SMe750 <sup>2</sup>	SM	0.14861	0.50133	0.6174

<sup>1</sup> Capability index based on the 400,000 SCC (Cpk400), 500,000 SCC (Cpk500), 600,000 SCC (Cpk600), 750,000 SCC (Cpk750) standards.

<sup>2</sup> Subclinical mastitis prevalence estimated from herd's Cpk400 (SMe400), Cpk500 (SMe500), Cpk600 (SMe600), Cpk750 (SMe750).

<sup>3</sup> Natural logarithm of subclinical mastitis prevalence (SM).

<sup>4</sup> All coefficients were significant (P<0.001).

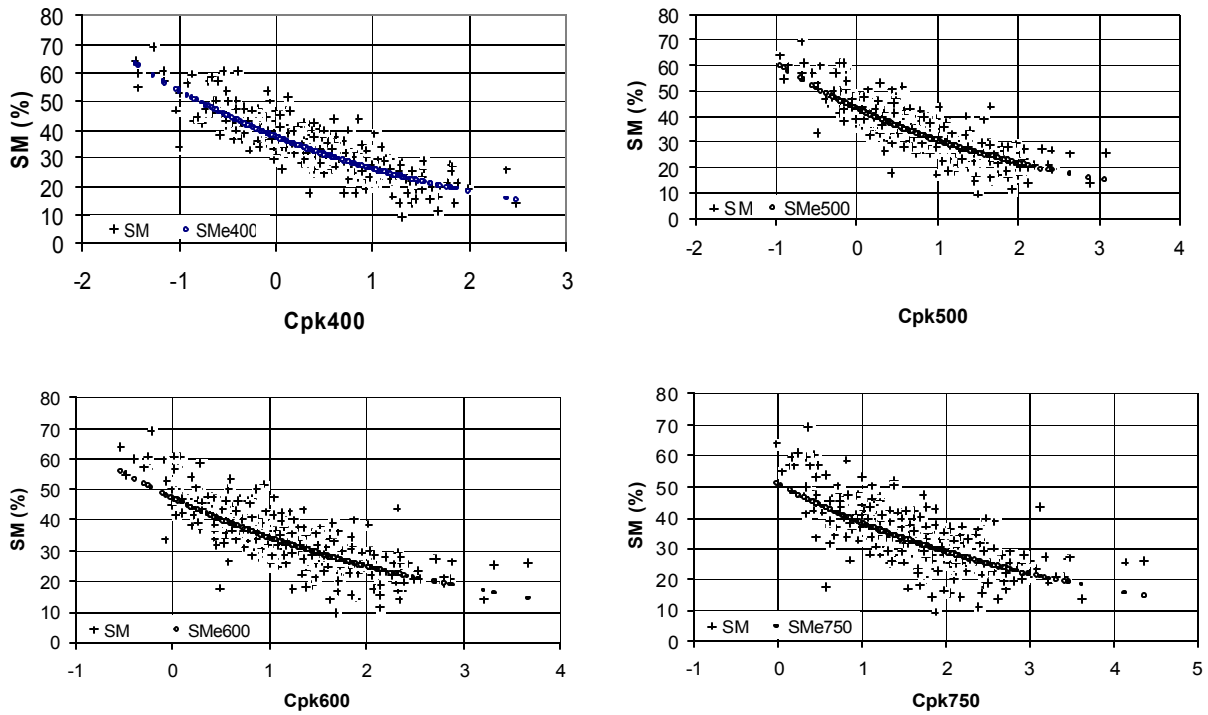


Figure 1. Scatter plot diagrams of the prevalence of subclinical mastitis (SM) as function of the capability indexes (Cpk400, Cpk500, Cpk600, Cpk750). The + represents the average SM observed for each farm. The o represents the average prevalence of subclinical mastitis (SMe400 SMe500 SMe600 and SMe750) estimated by the linear regression models developed based on four different SCC standards (400,000, 500,000, 600,000 and 750,000, respectively).

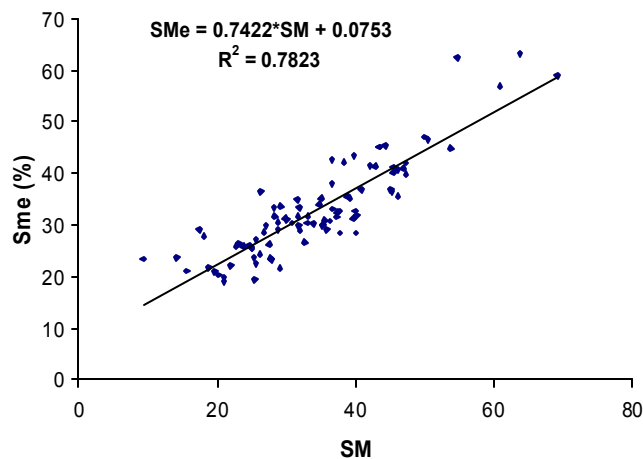


Figure 2. Subclinical mastitis prevalence (SM) of 89 herds plotted against the estimated subclinical mastitis (SMe).