Somatic Cell Counts, Mastitis and Milk Production in Selected Ontario Dairy Herds

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ABSTRACT

Somatic cell counts were performed monthly on bulk tank milk samples for all producers in the Ontario counties of Hastings, Lennox/Addington and Prince Edward throughout 1978 and 1979. Other data were obtained via a structured questionnaire and from the records of the Ontario Milk Marketing Board.

Many producers have not adopted practices that have been advocated for the integrated control of mastitis. For example, 43.3% of producers surveyed used single service paper towels, 63.3% regularly used teat dip and 56.5% dry cow therapy.

The mean of the average monthly somatic cell count for all producers for 1978 was 621.1 x 10^3 cells/mL. This latter value was used to divide the producers into case (higher than average) and control (lower than average) groups. Control herds averaged 95.9 liters more shipped milk per cow per month than case herds. Milk from control herds averaged 0.22 percentage points higher than case herds for each of average fat and lactose, and 0.16 percentage points higher for protein.

The linear regression of monthly shipped milk on the respective monthly bulk tank somatic cell count indicated a loss of 13.26 L/cow/month for each 100,000 increase in somatic cell count.

RÉSUMÉ

Cette étude consistait à effectuer, au cours des années 1978 et 1979, une énumération mensuelle des cellules somatiques du lait des bassins refroidisseurs de tous les producteurs des comtés suivants de l'Ontario: Hastings, Lennox-Addington et Prince Edward. On colligea d'autres données, à partir d'un questionnaire pertinent et des dossiers du Bureau de la mise en marché du lait de l'Ontario.

Plusieurs producteurs n'avaient pas encore adopté les mesures prônées pour la réalisation d'un contrôle intégré de la mammite. Par exemple, seulement 43,3% d'entre eux changeaient de serviette, d'une vache à l'autre, 63,3% utilisaient régulièrement les bains de trayons et 56,5%, l'antibiothérapie des vaches taries.

En 1978, l'énumération mensuelle des cellules somatiques atteignait, pour tous les producteurs, une moyenne de 621,1 x 10^3 cellules/mL. On se basa sur cette valeur pour différencier les troupeaux mammiteux des témoins; les premiers affichaient une moyenne supérieure à celle-ci, tandis que celle des seconds lui était inférieure. Les troupeaux témoins produisaient en moyenne 95,9 litres de lait de plus par vache, par mois, que les mammiteux. Le lait des troupeaux témoins contenait en moyenne 0,22% plus de gras et de lactose, ainsi que 0,16% plus de protéines, que celui des mammiteux.

La régression linéaire de la quantité de lait expédiée mensuellement, par rapport à l'énumération mensuelle des cellules somatiques du lait des bassins refroidisseurs, atteignit 13,26 L, par vache, par mois, chaque fois que cette énumération augmentait de 100 000.

INTRODUCTION

A recent survey of Ontario milk producers determined that many dairymen in the province had not adopted practices that have been advocated for the integrated control of bovine mastitis (4). Furthermore, a great many of the dairymen were not familiar with mastitis in its subclinical form and did not appreciate the losses in production associated with it. These findings tended to indicate that there was a need to increase farmers awareness of subclinical mastitis both with regard to factors associated with its control and to the resultant effects on productivity.

The objective of the study was twofold. First, to investigate the effects of various husbandry/management practices on bulk tank somatic cell counts and second, to evaluate the relationship between bulk tank somatic cell counts and milk production.

Although studies of a similar nature have been conducted elsewhere (1, 3, 5) an investigation of this type has not been conducted in Ontario.

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MATERIALS AND METHODS

Somatic cell counts (SCC) were performed monthly on bulk tank milk samples for all producers in the Ontario counties of Hastings, Lennox/Addington and Prince Edward throughout 1978 and 1979.

The samples were collected at one point and delivered to the Ontario Veterinary College (OVC) in iced chests. The samples were fixed, diluted and counted with a Coulter Milk Cell Counter (Coulter Electronics Ind., Hialeah, Florida) as described by Newbould (6). Other data were obtained via a structured questionnaire, and from the records of the Ontario Milk Marketing Board (OMMB).

The questionnaire was mailed to the producers early in 1979 and was used to collect data regarding each dairyman's husbandry/management practices, including the level of adoption of mastitis control procedures and his perception of clinical and subclinical mastitis.

The following OMMB production data was obtained on a monthly basis for each producer for the period 1978 and 1979; total milk shipped during the month (TOTMILK, liters); percent butterfat, protein and lactose (FAT, PROT, LACT) and the milk gel index (MGI). Average milk shipped per cow per month (SHIPMILK, L) was then estimated by dividing the quantity TOTMILK by the average number of milking cows in the herd.

The average monthly shipped milk per cow per month for the year 1978 (AVMILK, L) was calculated for each producer as was the average monthly somatic cell count (AVSCC, cells/mL) and the average monthly fat (AVFAT, %) protein (AVPROT, %) lactose (AVLACT, %) and milk gel index (AVGEL).

Analysis of the data was accomplished in four steps. First, in order to assess the husbandry/management practices of the entire population of producers under study, the results of the questionnaire were anlaysed. Second, the mean AVSCC (MEANSCC, cells/mL) for 1978 was determined for all producers. The producers were then divided into two groups with those above the average subsequently referred to as cases and those below as controls. The chi square test was used to determine the statistical association between husbandry/management factors and case or control status. Those variables for which a statistical association was found ($p \leqslant 0.05$) are listed, along with their description and coding in Table I. Stepwise discriminant analysis (7) was used to identify, from among the variables listed in Table I, those which were best able to differentiate between the two groups. The Student t-test was used to compare the two groups with respect to production data. Third, linear regression was used to investigate the relationship between SCC and SHIPMILK. Finally, multiple linear regression was used to investigate the effect of several mastitis control procedures on each of AVMILK and AVSCC.

TABLE I. Variables Associated with Group Status in a Case Control Study of Bovine Mastitis

Variable	Description and Codes
ASSOC	Member of a production recording scheme (1) DHIA, (2) ROP, (3) NONE
KNOWDEF	Understand the meaning of the term subclinical mastitis. YES = 1, NO = 0
TOWEL	Prepare udder using single service towel. YES = 1, NO = 0
DURATION	Years operating the farm 0-5 = 1, 6-10 = 2, 11-15 = 3, 16-20 = 4, 21-25 = 5, 26-30 = 6, greater than 31 = 7
MILKSYST	Milking system. Milking parlor = 1, Highline pipeline = 2, Lowline pipeline = 3, Bucket milker = 4, Step-saver = 5
TEATDIP	Teat dip, YES = 1, NO = 0
VETVISITS	Monthly or bimonthly veterinary visits, YES = 1, NO = 0
DRYCOW	Dry cow treat all cows, YES = 1, NO = 0
TIME	Upper limit of interval between start of stimulation and commencement of milking (minutes) 0.5 = 1, 1 = 2, 1.5 = 3, 2 = 4, 2.5 = 5, 3 = 6, Over 3 = 7
HERDSIZE	Number of cows milking
MECH	Mechanized or partially mechanized feeding system and mechanized manure handling system YES = 1, NO = 2
MAINACT	Principal farming activity, DAIRY = 1, OTHER = 2

RESULTS

The response rate to the questionnaire was 63%.

The average number of cows being milked was found to be 30.4. Membership in a performance recording scheme was reported by 51.5% of respondents with 35.9% belonging to Dairy Herd Improvement (DHI) and 15.6% to Record of Performance (ROP). A housing system where cows were tied was used by 89% of respondents and 46.3% used a high line pipeline, 8.9% parlours, 2.3% low line pipelines, 36.3% bucket milkers and 5.8% step-savers.

The level of adoption of several management practices is presented in Table II. Approximately one-third (33.4%) of the producers indicated the use of a reusable cloth for udder and teat preparation. Approximately two-thirds

TABLE II. Percentage Adoption of Several Factors Associated with Mastitis Control in Selected Ontario Dairy Herds

Item	Percent
Preparation of teats before milking	
— reusable cloth	33.4
— single use towel	43.3
— water hose	2.1
Use of teat dip	63.3
Drying off therapy	
— selective use	25.0
— all cows treated	31.5

(63.3%) of the producers used teat dip and 56.5% dry cow therapy (Table II).

Other findings were as follows: 41.3% of producers used their inflation tubes for 2000 cow milkings or more, 57.5% scrutinized foremilk, 23% felt they waited 2.5 minutes or more between the start of stimulation and the attachment of the milking unit, 56% regularly "machine stripped" their cows, 24.9% reported regular monthly or bimonthly veterinary service and 56.4% indicated familiarity with mastitis in its subclinical form (the latter term was defined in the body of the questionnaire).

The means of several production related variables are presented in Table III. The mean of the average monthly somatic cell count (MEANSCC) for all producers for 1978 was 621.2 x 10^3 cells/mL. This latter value was used to divide the producers into the case and control groupings.

The case and control groups are compared with respect to production data in Table IV. The two groups were statistically significantly different ($p \leqslant 0.01$) for all production related variables except for AVPROT with mean values for the control group being higher than the cases for all variables except AVSCC and AVGEL. Control herds averaged 95.9 liters more shipped milk per cow per month than case herds. Milk from control herds averaged 0.22 percentage points higher than case herds for each of AVFAT and AVLACT, and 0.16 percentage points higher for AVPROT.

The results of the discriminant analysis are presented in Table V. The variables including the means for each of the case and control groups, and the standardized discriminant function coefficients, are listed by order of entry into the discriminant function. Of the variables entered into the discriminant analysis (Table I) only the variable MAINACT was excluded from the discriminant function by the final iteration of the stepwise procedure.

Control herds, in comparison to case herds (Table V), were more likely to belong to a production recording scheme, use teat dips, be familiar with subclinical mastitis, use single service paper towels, have a more mechanized feeding and manure handling system, have operated the dairy farm for fewer years, have a slightly larger herd, be more likely to have a milking parlor or pipeline milking system, use dry cow antibiotic therapy and have regular monthly or bimonthly veterinary service. On average

TABLE III. Means[a] of Several Production Related Variables for Selected Ontario Dairy Herds

Variable	Mean ± SD
AVMILK (L) shipped milk/cow/month	452.7 ± 124.8
MEANSCC ('000 cells/mL)	621.2 ± 249.8
AVFAT (%) (butterfat)	4.12 ± 1.14
AVPROT (%) (protein)	3.60 ± 1.20
AVLACT (%) (lactose)	5.30 ± 0.88
AVGEL (%) (milk gel index)	11.4 ± 9.9

[a]Mean monthly values for year 1978
N = 476 for AVMILK, 746 for MEANSCC and AVGEL, 765 for AVFAT, AVPROT and AVLACT

TABLE IV. Means and Comparison of Production Variables in Case Control Study of Bovine Mastitis

Variable[a]	Control Producers	Case Producers
AVMILK (L)	482.5 ± 123.0[b] (328)[c]	386.6 ± 101.5 (148)
AVSCC ('000/mL)	459.8 ± 97.0 (444)	859.3 ± 213.0 (301)
AVFAT (%)	4.20 ± 1.35 (464)	3.98 ± 0.69 (301)
AVPROT (%)	3.66 ± 1.43 (464)	3.50 ± 0.71 (301)
AVLACT (%)	5.39 ± 1.04 (464)	5.17 ± 0.52 (301)
AVGEL	5.33 ± 4.32 (446)	20.41 ± 8.96 (301)

[a]See text for explanation
[b]Mean ± SD
[c]Number of herds

TABLE V. Means of Variables and Results of Discriminant Analysis. Case Control Study of Bovine Mastitis

Variable[a]	Control Producers	Case Producers	Standardized Discriminant Coefficient
ASSOC	1.68 ± 0.87[b]	2.78 ± 0.61	-0.42
TEATDIP	0.79 ± 0.41	0.22 ± 0.42	0.28
KNOWDEF	0.75 ± 0.43	0.19 ± 0.40	0.30
TOWEL	0.67 ± 0.52	0.12 ± 0.33	0.30
DURATION	4.83 ± 2.26	5.87 ± 1.86	-0.12
MECH	1.60 ± 0.49	1.82 ± 0.38	-0.09
HERDSIZE	31.27 ± 12.53	28.42 ± 9.47	-0.16
MILKSYST	2.52 ± 1.03	3.57 ± 0.97	-0.16
DRYCOW	0.25 ± 0.43	0.12 ± 0.33	0.09
VETVISITS	0.23 ± 0.42	0.04 ± 0.19	0.09
TIME	2.98 ± 1.62	2.96 ± 1.70	0.08
Number of Herds	464	301	
Discriminant function group centroids	0.81	-1.24	
Percent of herds correctly classified	83.8	82.4	

[a]See Table I for definitions and codes, variables listed in order of entry into disciminant function
[b]Mean ± SD

there was a tendency for control producers to wait longer between the start of stimulation and attachment of the milking unit.

The group centroids were 0.81 and -1.24 for the case and control producers respectively. The discriminant function correctly classified 83.8% of the control and 82.4% of the case herds for an overall correct classification of 83.3%.

The linear relationship between monthly bulk tank somatic cell count (SCC) and SHIPMILK was found to be;

SHIPMILK (L/cow/month)
= 536.42-0.1326x(SCC;'000/mL)
($n=10118; r^2=0.05; p \leq 0.01$)

Utilizing a plot of the actual values it appeared that there was little additional decrease in SHIPMILK beyond a somatic cell count of approximately 1.25×10^6 cells/mL.

The partial regression coefficients for each of TEATDIP, DRYCOW and TOWEL (Table I) and for each of the dependent variables AVSCC ('000 cells/mL) and AVMILK (l/cow/month) are presented in Table VI. Each of the control steps investigated had a negative effect on AVSCC and a positive effect on AVMILK. However DRYCOW by itself did not have a statistically significant effect on AVSCC and neither DRYCOW nor TOWEL on AVMILK ($0.1 > p > 0.05$). TEATDIP was highly significant in both instances ($p \leq 0.01$).

DISCUSSION

The results of the questionnaire were, in general, similar to those obtained by a survey of randomly selected Ontario producers and which had been conducted by the authors (4) at approximately the same time as the present study. This indicates that while many of the producers in the present study had not adopted practices that have been advocated for the integrated control of mastitis, they were not atypical of the province as a whole. However, the results would further emphasize the need to better educate producers regarding mastitis with due regard being given both to the need for integrated control measures and to the influence of mastitis on production.

In this retrospective study, the average monthly somatic cell count for the year 1978 was used to divide the study population into case and control groups. The average somatic cell count for the case and control group was 459.8×10^3 and 859.3×10^3 cells/mL respectively (Table III). Control herds had higher average production levels than did case herds, averaging 95.9 liters more shipped milk per cow per month and 0.22 percentage points higher for each of mean yearly fat and lactose and 0.16 percentage points higher for protein with all differences being statistically significantly different ($p \leq 0.05$) except percentage protein. However, the authors hasten to point out that while some of these latter differences in production are no doubt associated with differences between the two groups with regard to mastitis levels other factors, which it was impossible to assess by means of the questionnaire, are quite probably also involved.

A number of husbandry/management factors were found to be statistically associated with group membership (Table I). On the basis of the absolute magnitude of the discriminant coefficients the variable which was best able to differentiate between the case and control groups was ASSOC (Table V). As neither the DHI nor ROP were playing an active role in the area of mastitis control at the time the study was conducted, the authors interpret this as meaning that producers who belong to such production recording associations are generally more progressive and hence because of this are more likely to adopt mastitis control measures as opposed to any direct effect of membership *per se*. This is further substantiated by the fact that control producers were more likely to have a mechanized or partially mechanized feeding system and mechanized manure handling system (MECH), and were more likely to have milking parlors or pipeline milking systems (MILKSYST). Control producers were also more likely to understand the meaning of the term subclinical mastitis.

Other variables that entered into the discriminant function early were TEATDIP and TOWEL with control producers much more likely to use each of these mastitis control measures than were case producers (79% vs 22% and 67% vs 12% respectively).

Control producers had operated the farm for fewer years than case producers and on average had slightly larger herds (31.27 vs 28.42 milking cows). Control producers were more likely to use dry cow therapy on all cows (25% vs 12%) and have regular veterinary service (23% vs 4%).

In general, these findings agree with a similar investigation conducted previously by one of the authors (2) and reconfirm the importance of procedures such as the use of teat dip, single service paper towels and dry cow antibiotic therapy for mastitis control. Underlying the need to implement these procedures is the need to better educate producers regarding

TABLE VI. Partial Regression Coefficients for Several Mastitis Control Steps for Mean Monthly SCC and Production per Cow

Control Step	Mean Monthly SCC ('000s/mL)	Mean Milk/cow/month (liters)
Teat dipping	-105.6[a]	41.7[b]
Dry cow therapy (all cows treated)	-3.2	23.3[c]
Single service towels	-43.0[b]	21.5[c]
Constant	650.0	410.1

N = 419
[a]($P \leq 0.01$)
[b]($P \leq 0.05$)
[c]($0.1 > P < 0.05$)

mastitis, particularly its subclinical form (75% of control producers were familiar with it opposed to 19% of the cases), with emphasis being given to its influence on production and the rate of return on funds invested in its control.

The linear regression of monthly shipped milk (SHIPMILK, L/cow/month) on the respective monthly somatic cell count (SCC, '000 cells/mL) indicated a loss of 13.26 l/cow/month for each 100,000 increase in somatic cell count. The regression indicated that only 5% of the total variation in production per cow per month could be accounted for by the bulk tank somatic cell count. This agrees with the findings of others (1, 5) and is not surprising as many factors other than mastitis influence production levels in a herd. Nevertheless, the regression was significant ($p \leqslant 0.01$).

The partial regression coefficients for each of teat dipping and the use of single service towels were significant and had a negative, i.e. lowering, effect on mean monthly somatic cell count for the period investigated, i.e. 1978. The use of dry cow therapy also had a negative effect but when the influence of the other two steps were statistically controlled for, the effect of the variable DRYCOW by itself, was not significant. Producers who used the control program (Table VI), i.e. TEATDIP, DRYCOW and TOWEL had an apparent reduction of approximately 150,000 cells/mL in their bulk tank milk and had an apparent increase in milk production of 86.5 l/cow/month. However, utilizing the results of the regression of SHIPMILK on monthly SCC one would only expect a gain of 19.9 l/cow/month for a similar drop in cell count. Thus, it seems likely that about 20-25% of the apparent gain is associated with the control steps and the resultant reduction in mastitis, and the rest with other factors associated with farmers with better than average management skills. Similar findings have been reported by others (5).

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