

## Relationship between milking management practices and milk somatic cell counts on local dairy farms

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### Summary

Milking management practices on 1373 dairy farms located in the district of Tokachi, Hokkaido were surveyed and their effects on the somatic cell counts (SCC) were analyzed. The measures relating to the milking management practices were analyzed on the dairy herds: the rate of adoption of recommended milking managements; relationship between milking managements and annual weighted average bulk tank milk SCC (BMSCC); and annual average SCC linear score of individual cows. The managements that have the significant influence on number of SCC were: cow body cleanliness, dry cow therapy, timing of post-dipping, no over-milking, type of dipper, wearing rubber gloves and proper antibiotic infusion. BMSCC ( $\log(X/10^3)$ ) decreased from 2.21 to 2.14 as the number of the practiced managements increased, while BMSCC increased from 2.31 to 2.45 as the unpracticed managements increased. The SCC linear score decreased from 2.65 to 2.36 as the number of the practiced managements increased, and it increased 2.96 to 3.76 as the unpracticed managements increased. The simultaneous practice of milking managements that were highly influential on SCC was more efficient for decreasing SCC and their improvement of milk quality.

Keywords : bovine mastitis, milking management, somatic cell counts, linear score, multivariate analysis

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### Introduction

The importance of recommended management practices for prevention of bovine mastitis has been well documented<sup>1, 3, 5, 8)</sup>. The recommended milking managements such as milking practices, maintenance of milking system, cows' environment condition and feeding have significant impacts on the udder health and milk quality<sup>2, 4, 11)</sup>. It has been shown that milking management practices affect BMSCC<sup>6, 10)</sup>. However, only few extensive researches that cover many farms have been made so far. The purpose of

this study was to evaluate the relationship between the recommended milking management practices on the farms and SCC level and milk quality on local dairy farms in Tokachi district, Hokkaido, Japan.

### Materials and Methods

#### Data collection

Questionnaires about milking management practices were carried out to the dairy farmers made by veterinarians on 1373 dairy farms in Tokachi district, Hokkaido. These included 818 farms that affiliate Japanese Dairy Herd Improvement Society (DHIA). The items of the questionnaires that could be subjectively assessed were observed by DHIA personnel at milking time on those 818 farms (table 1). After the survey, the collected data were compiled per item, and the relationship between milking management practices and the annual average BMSCC was analyzed. The relationship between the milking man-

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agement practices and the annual average SCC linear score of individual cows was also analyzed on the DHIA farms.

### Statistics

The statistical analyses were performed by *t*-test, one-way layout analysis of variance and quantification method type I as multiple regression analysis with variables<sup>7)</sup>. On this analysis, numeric values on the annual average BMSCC which had been divided by  $10^3$  and log-transformed ( $\log(X/10^3)$ ) afterward were utilized.

### Results

The recommended milking managements that practicing rates were low on dairy farms were udder hair clipping, timely liner exchange, teat drying before milking, wearing rubber gloves and forestripping. The annual average BMSCC and average SCC linear scores on dairy farms were analyzed in comparison to the milking management practices (table 2). Significant differences of BMSCC levels and SCC linear scores of farms were found in 12 out of 21 items that had practiced the managements properly on the farms, compared to those of farms that had not practiced them. The correlation between actual BMSCC and the theoretical value of the BMSCC were analyzed, and the coefficient of determination with coordinated degrees of freedom ( $R^2$ ) was 0.18, and the multiple correlation coefficient ( $R$ ) was 0.42, respectively by the quantification method type I (table 3). The correlation between actual annual average linear score and the theo-

retical value of annual average linear score were analyzed, and the coefficient of determination with coordinated degrees of freedom ( $R^2$ ) was 0.21, and the multiple correlation coefficient ( $R$ ) was 0.46, respectively (table 3).

The partial correlation coefficient and the item ranges of each milking managements on the linear multiple regression expression were placed from 1 to 18 in order of their numeric value, showing the influence of the milking managements on SCC or SCC linear score (table 4). Seven managements, ie., Rank 1 to 7, were observed to be influential to the results of SCC. The relationship between number of milking management practices and their number of SCC on dairy farms was evaluated. Increasing the milking management practices simultaneously, the number of average BMSCC decreased from  $2.21 \pm 0.16$  to  $2.14 \pm 0.16$  ( $\log(\text{mean}/10^3) \pm \text{SD}$ ). Increasing the milking managements that do not perform, BMSCC increased from  $2.31 \pm 0.16$  to  $2.45 \pm 0.15$  ( $\log(\text{mean}/10^3) \pm \text{SD}$ ) (fig.1). Increasing the milking management practices simultaneously, the average SCC linear score decreased from  $2.65 \pm 0.53$  to  $2.36 \pm 0.45$  (mean  $\pm$  SD). Increasing the milking managements that do not practice, the SCC linear score increased from  $2.96 \pm 0.58$  to  $3.76 \pm 0.57$  (mean  $\pm$  SD) (fig.2). Significant ( $P < 0.01$ ) differences on the BMSCC and the SCC linear score were found between the two groups, one was that the practiced managements were added in a row and another that unpracticed managements were added.

Table 1. Survey of milking management practices on 1373 dairy farms by hearing and observatory process

Hearing survey	Observation by DHIA personnel
1. Presence of rubber glove wearing	1. Timing of teat cup attaching
2. Type of disinfectant	2. Technique of teat cup attaching
3. Presence of forestripping	3. Presence of liner slip
4. Way of teat washing	4. Presence of machine stripping
5. Presence of teat drying after teat washing	5. Presence of overmilking
6. Presence of pre-dipping	6. Way of unit removing
7. Presence of post-dipping	7. Timing of post-dipping
8. Type of dipper	8. Cow body cleanliness factor
9. Presence of udder hair clipping	9. Degree of cow's bed drying
10. Presence of dry cow therapy	
11. Way of insertion of antibiotic	
12. Presence of proper liner exchanging	
13. Type of milking system	

Table 2. Relationship between recommended managements (21items) of milking cows and their SCCs in milk surveyed on 818 dairy farms

Items	Detail	Annual average BTSCC log (X/10 <sup>8</sup> )				Annual average SCC linear score			
		Response	Average	SD	Difference	Response	Average	SD	Difference
Wearing rubber gloves	Yes	311	2.24	0.17	]**	203	2.65	0.55	]**
	No	984	2.27	0.17		559	2.79	0.57	
Use of disinfectant	Yes	767	2.26	0.18	ns	488	2.74	0.58	ns
	No	606	2.26	0.16		330	2.77	0.54	
Forestripping	Yes	956	2.26	0.17	ns	569	2.73	0.56	ns
	No	417	2.27	0.17		249	2.80	0.57	
Region of teat washing	Teat only	524	2.24	0.16	ns	524	2.75	0.57	ns
	Teat and udder	294	2.24	0.17		294	2.76	0.55	
Teat washing	After pre-milking	436	2.27	0.17	ns	263	2.68	0.56	]*
	Before pre-milking	414	2.25	0.18		289	2.78	0.56	
	No teat washing	523	2.27	0.16		266	2.79	0.57	
Pre-dipping	Yes	140	2.25	0.16	ns	98	2.74	0.58	ns
	No	1233	2.26	0.17		720	2.75	0.56	
Timing of teat cup attaching after fore-stripping	Within 1 min.	487	2.22	0.16	]**]**	487	2.69	0.54	]**]**
	Over 1 min.	273	2.27	0.16		273	2.81	0.60	
	Inconsistent	58	2.3	0.15		58	2.97	0.52	
Air indraft into the teat cup	No	448	2.23	0.16	ns	448	2.74	0.57	ns
	Occasionally	318	2.25	0.17		318	2.75	0.56	
	Yes	52	2.27	0.19		52	2.81	0.57	
Liner slip	No	434	2.23	0.16	]*	434	2.73	0.56	ns
	Occasionally	368	2.25	0.17		368	2.77	0.57	
	Yes	16	2.32	0.17		16	2.82	0.57	
Machine stripping	No	405	2.23	0.16	ns	405	2.71	0.57	ns
	Occasionally	260	2.26	0.17		260	2.78	0.57	
	Yes	153	2.25	0.16		153	2.79	0.53	
Overmilking	No	618	2.23	0.16	]**]**	618	2.70	0.55	]**]**
	Occasionally	166	2.27	0.17		166	2.9	0.58	
	Yes	34	2.33	0.13		34	2.99	0.52	
Timing of unit removing	Simultaneously	609	2.24	0.16	ns	609	2.73	0.56	ns
	Nearly same timing	173	2.25	0.17		173	2.84	0.58	
	Inconsistent	36	2.21	0.19		36	2.68	0.58	
Timing of post-dipping	Immediate	667	2.22	0.16	]**]**	667	2.69	0.54	]**]**
	Not immediate	72	2.29	0.16		72	2.88	0.52	
	Do not make	79	2.34	0.13		79	3.19	0.59	
Type of dipper	Unreturn	200	2.21	0.17	]**	137	2.62	0.53	]**]**
	Spray	413	2.24	0.17		254	2.63	0.54	
	Return	440	2.26	0.17		270	2.76	0.54	
Post-dipping	Yes	1111	2.24	0.17	]**	700	2.69	0.55	]**
	No	262	2.33	0.15		118	3.10	0.54	
Udder hair clipping	Yes	252	2.21	0.17	]**	167	2.68	0.56	ns
	No	1121	2.27	0.17		651	2.77	0.56	
Cow body cleanliness	Clean	557	2.21	0.16	]**	557	2.65	0.53	]**
	Not clean	261	2.31	0.16		261	2.96	0.58	
Dry cow therapy	All Cows	1026	2.24	0.17	]**]**	652	2.67	0.54	]**]**
	Specific cows	288	2.33	0.16		148	3.04	0.55	
	Do not make	59	2.34	0.16		18	3.16	0.47	
Antibiotics insertion	Partial	639	2.24	0.17	]**	422	2.68	0.56	]**
	Full	710	2.28	0.17		379	2.83	0.56	
Type of milking system	Parlour	113	2.24	0.18	ns	61	2.49	0.48	]**]**
	Pipe line	1146	2.26	0.16		738	2.77	0.56	
	Bucket	114	2.28	0.21		19	2.88	0.66	
Cow's bed	Dry	668	2.22	0.16	]**	668	2.67	0.52	]**
	Wet	150	2.32	0.06		150	3.09	0.62	

ns; not significant, \*; P&lt;0.05, \*\*; P&lt;0.01

Table 3. Results of 18 items of recommended management practices analyzed by quantification method type I

Items	Detail	Degree	Annual average BTSCC log (X/10 <sup>5</sup> )			Annual average SCC linear score		
			P.R.C	Range	Ave.	P.R.C	Range	Ave.
Wearing rubber gloves	Yes	203	-0.0139	0.0369	2.22	-0.0643	0.1373	2.65
	No	559	0.0079		2.25	0.0337		2.79
	Others	56	-0.0289		2.22	-0.1036		2.66
Use of disinfectant	Yes	488	0.0052	0.0129	2.24	0.0017	0.0041	2.74
	No	330	-0.0077		2.24	-0.0025		2.77
Region of teat washing	Teat only	524	0.0019	0.0053	2.24	0.0019	0.0052	2.75
	Teat and udder	294	-0.0034		2.24	0.0033		2.76
Teat washing	After pre-milking	263	0.0007	0.0115	2.23	-0.0151	0.0260	2.68
	Before pre-milking	289	-0.0059		2.24	0.0109		2.78
	No teat washing	266	0.0056		2.26	0.0031		2.79
Pre-dipping	Yes	98	0.0162	0.0184	2.23	-0.1032	0.1172	2.74
	No	720	-0.0022		2.24	-0.0140		2.75
Air indraft into the teat cup	No	448	0.0002	0.0092	2.23	0.0123	0.0432	2.74
	Occasionally	318	0.0010		2.25	-0.0123		2.75
	Yes	52	-0.0082		2.27	-0.0309		2.81
Timing of teat cup attaching after fore-stripping	Within 1 min.	487	-0.0085	0.0372	2.22	-0.0211	0.1347	2.69
	Over 1 min.	273	0.0092		2.27	0.0135		2.81
	Inconsistent	58	0.0287		2.30	0.1136		2.97
Liner slip	No	434	0.0075	0.0617	2.23	0.0461	0.1002	2.73
	Occasionally	368	-0.0111		2.25	-0.0540		2.77
	Yes	16	0.0506		2.32	-0.0093		2.82
Machine stripping	No	405	-0.0009	0.0192	2.23	0.0156	0.0616	2.71
	Occasionally	260	0.0079		2.26	0.0027		2.78
	Yes	153	-0.0112		2.25	-0.0460		2.79
Overmilking	No	618	-0.0040	0.0822	2.23	-0.0258	0.2088	2.70
	Occasionally	166	-0.0012		2.27	0.0586		2.90
	Yes	34	0.0782		2.33	0.1830		2.99
Timing of unit removing	Simultaneously	609	0.0029	0.0325	2.24	-0.0101	0.0664	2.73
	Nearly same timing	173	-0.0039		2.25	0.0409		2.84
	Inconsistent	36	-0.0296		2.21	-0.0256		2.68
Timing of post-dipping	Immediate	667	-0.0104	0.0661	2.22	-0.0385	0.2852	2.69
	Not immediate	72	0.0355		2.29	0.0857		2.88
	Do not make	79	0.0557		2.34	0.2467		3.19
Type of dipper	Unreturn	137	-0.0268		2.20	-0.0637		2.62
	Spray	254	-0.0185	0.0533	2.21	-0.0698	0.2163	2.63
	Return	270	0.0156		2.26	0.0128		2.76
	Not use	157	0.0265		2.30	0.1465		3.03
Udder hair clipping	Yes	167	-0.0218	0.0274	2.20	-0.0193	0.0243	2.68
	No	651	0.0056		2.25	0.0050		2.77
Cow body cleanliness	Clean	557	-0.0251	0.0788	2.21	-0.0842	0.2638	2.65
	Not clean	261	0.0536		2.31	0.1796		2.96
Dry cow therapy	All cows	652	-0.0142	0.0703	2.22	-0.0582	0.3533	2.67
	Specific cows	148	0.0561		2.31	0.2206		3.04
	Do not make	18	0.0537		2.33	0.2950		3.16
Antibiotic insertion	Partial	422	-0.0137	0.0464	2.22	-0.0318	0.1544	2.68
	Full	379	0.0138		2.27	0.0299		2.83
	Not use	17	0.0327		2.26	0.1226		2.79
Type of milking system	Parlour	61	-0.0091	0.0630	2.19	-0.1256	0.1365	2.49
	Pipe line	738	0.0023		2.25	0.0108		2.77
	Bucket	19	-0.0607		2.21	-0.0164		2.88
Coefficient of determination					0.211		0.241	
Coefficient of determination adjusted for the degrees of freedom					0.179		0.210	
Multiple correlation coefficient adjusted for the degrees of freedom					0.423		0.458	

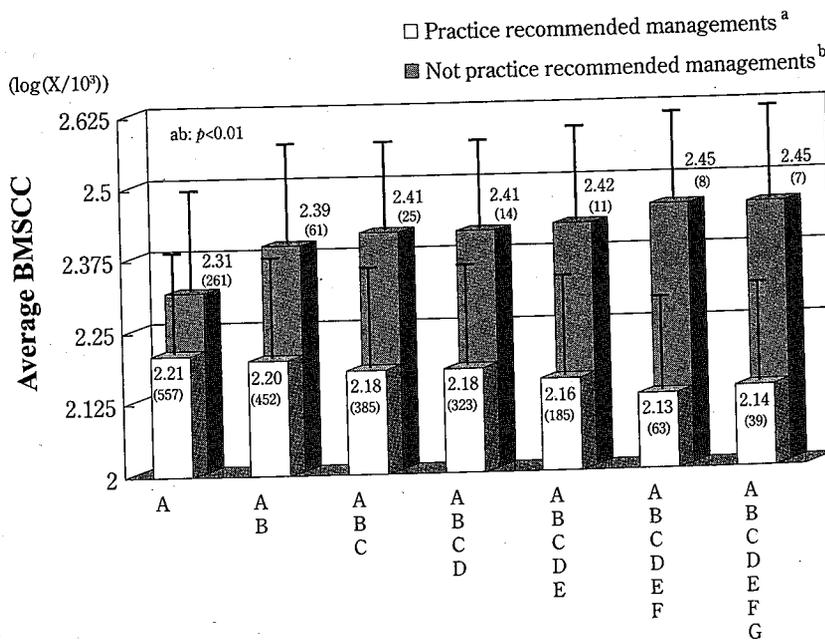
Range; The difference of minimum and maximum values and the size of contributing rate  
P.R.C.; Partial regression coefficient

Table 4 The Rank and coefficient values of partial correlation between 18 items of milking management practices and the number of somatic cells in milk on 818 dairy farms

Item	Annual average BTSCC log (X/10 <sup>6</sup> )				Annual average linear score				Rank Sum	Rank
	Range	Rank	P. correlation	Rank	Range	Rank	P. correlation	Rank		
Cow body cleanliness factor	0.079	2	0.231	1	0.264	3	0.229	1	7	1
Dry cow therapy	0.070	3	0.181	2	0.353	1	0.221	2	8	2
Timing of post-dipping	0.066	4	0.141	3	0.285	2	0.156	3	12	3
Overmilking	0.082	1	0.109	5	0.209	5	0.096	6	17	4
Type of dipper	0.053	7	0.134	4	0.216	4	0.141	4	19	5
Wearing rubber gloves	0.037	10	0.081	7	0.137	7	0.099	5	29	6
Antibiotic insertion	0.046	8	0.095	6	0.154	6	0.070	10	30	7
Liner slip	0.062	6	0.076	8	0.100	11	0.086	7	32	8
Milking system	0.063	5	0.065	11	0.136	8	0.070	9	33	9
Timing of teat cup attaching	0.037	9	0.073	9	0.135	9	0.067	11	38	10
Pre-dipping	0.018	14	0.039	15	0.117	10	0.073	8	47	11
Unit removing	0.032	11	0.046	12	0.066	12	0.043	13	48	12
Machine stripping	0.019	13	0.045	13	0.062	13	0.043	12	51	13
Udder hair clipping	0.027	12	0.073	10	0.024	16	0.019	16	54	14
Teat washing order	0.012	16	0.032	16	0.026	15	0.021	15	62	15
Air indraft into the teat cup	0.009	17	0.014	18	0.043	14	0.025	14	63	16
Disinfectant	0.013	15	0.043	14	0.004	18	0.004	18	65	17
Region of teat washing	0.005	18	0.017	17	0.005	17	0.005	17	69	18

P. correlation ; Partial correlation

\* Data were analyzed by quantification method type I



A: Cow body cleanliness    B: Dry cow therapy    C: Timing of Post-dipping  
 D: No overmilking    E: Type of dipper    F: Use of rubber gloves  
 G: Proper antibiotic insertion

Fig. 1. Relationship between bulk tank milk somatic cell counts and implementation of recommended milking managements on 818 dairy farms

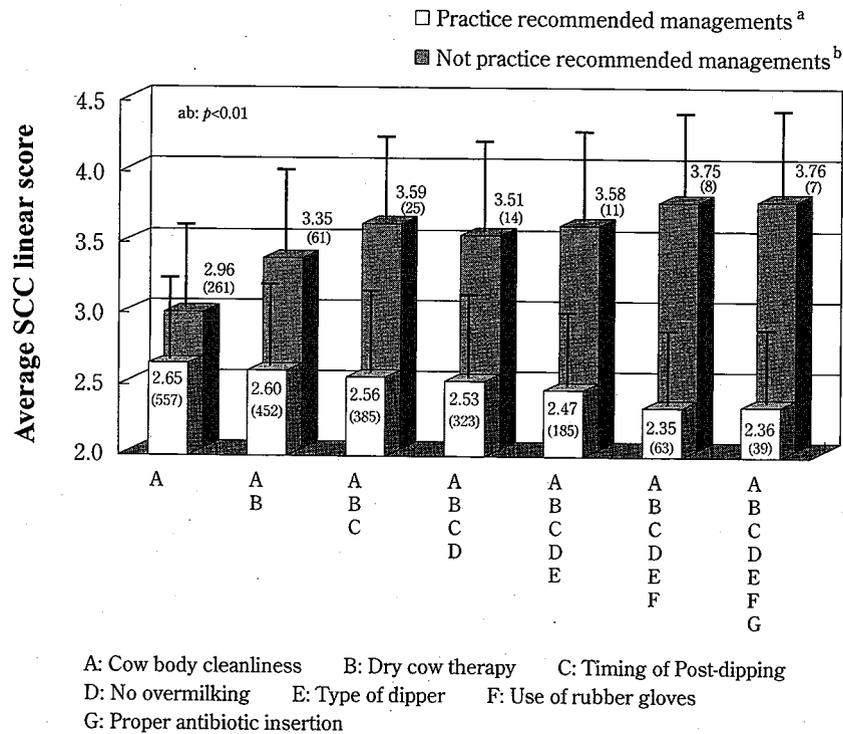


Fig. 2. Relationship between somatic cell counts linear score and implementation of recommended milking managements on 818 dairy farms

## Discussion

Bovine mastitis is a disease that causes serious economical damages to the farms. It includes the damages such as decrease in milk productivity, decline in milk quality and milk wasting, the cost of the treatment and loss due to higher culling rate. It has been shown that practice of the recommended milking managements have a significant effects on the improvement of milk quality and prevention of mastitis. However, those skills appear to be insufficient on all dairy farms, and farmers need to be practiced all those useful skills more effectively. MILLER and colleague reported that the practice rate of the post-dipping and the dry cow therapy were 90 percent in rate at 209 DHI farms in Ohio<sup>9)</sup>. However, they reported, at those farms, the practice rate of the other managements had not been very high notwithstanding able farmers. We found that the milking managements which had been recommended to prevent mastitis such as post-dipping, no overmilking and the dry cow treatment with antibiotics were implemented widely on the farms, while the skills which had been recommended such as udder hair clipping, wearing rubber gloves and teat drying

before milking were performed at comparatively lowered level. Judging from the coefficient of determination by regressions against all fluctuation, the general influences of the items on the BMSCC and the SCC linear score were able to be explained as 20%. If the extensive consideration that includes the other items that had not been selected for this analysis such as the milking system planning and its maintenance the feeding technique, and the type of mastitis causing pathogens.

In this study, we found that the improvement of SCC were led by milking hygiene and milking technique that have been performed with simultaneous practices of seven managements that have high correlation with SCC. Further, this survey showed that the milking managements that we have always recommended to the farmers are very important to decrease SCC. However, these managements have not been widespread enough yet, further enlightenment will be needed. In conclusion, the finding that the simultaneous practice of these managements that have high correlation with SCC appeared to very effective on the improvement of milk quality so that they should be surely practiced as the most important items at the farms.

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## 要 約

## 〈酪農場における搾乳管理衛生と体細胞数との関連〉

推奨されている搾乳衛生が体細胞数に及ぼす影響を知るために、北海道十勝地方の1373戸の酪農家を対象に調査を行った。調査方法は、客観的に評価できる項目を獣医師による聞き取り調査で、また客観的に評価困難な項目については乳検検定時に検定員により調査した。統計学的分析はt検定、一元配置分散分析、多変量解析数量化I類を用いて行った。体細胞数に最も影響度の高かった搾乳衛生は、牛体清潔度、乾乳期治療の有無、ポストディッピングの実施時期、過搾乳の有無、ディッパーの種類、搾乳手袋装着の有無、乳房炎軟膏の注入の仕方であった。また、この7つの作業を影響度の高い作業から順に加えて同時実施していくと、平均バルク乳体細胞数 ( $\log(X/10^9)$ ) は2.21から2.14へ減少し、同時実施しない作業を増やしていくと2.31から2.45へ増加した。同様に影響度の高い作業から順に同時実施していくと、平均体細胞リニアスコアは2.65から2.36に減少し、同時実施しない作業を増やしていくと2.96から3.76に増加した。

以上のことから、現在推奨されている搾乳衛生は、体細胞数を低減する上で重要であることが確認できた。また、体細胞数に相関が高い作業の同時実施により体細胞数の低減効果が高いことが明らかになったことから、これらの作業を含めた推奨作業の同時実施が重要であり、特に相関の高かった作業の確実な実施を指導する必要があると考えられた。

キーワード：牛乳房炎、搾乳衛生、体細胞数、リニアスコア、多変量解析