An Integrated Quality Control System to Provide Dairy Farmers with Management Advice to Control Mastitis and Improve Profitability

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Abstract

An integrated system of quality control which incorporates information obtained from a standardized recording form (instrument) based on milking management performance has been developed and validated. The instrument was tested to determine whether it is more effective during a farm visit at consistently defining problems causing suboptimal udder health compared to using existing veterinary investigative procedures. The instrument provides specific scoring criteria for the most important 46 individual management practices associated with suboptimal udder health. A convenience sample of 26 dairies serviced by 9 veterinarians from 5 veterinary practices with an average scc greater than 250,000 were randomly assigned into instrument-advice (IA) and veterinary practice-advice (VPA) study groups. Rounds 1, 2 (6 months), and 3 (12 months) for all the dairies consisted of collecting a bulk tank culture, scoring each dairy's milking management practices, recording data on mastitis losses, collecting DHI data and milk processing plant results, taking milking time vacuum recordings, and recording data on costs for changes made as a result of the plan of action (rounds 2 and 3 only). Each VPA dairy's veterinarian received only the bulk tank culture results and reported those to the dairy operator and was free to implement a plan of action. Each IA dairy's veterinarian also received all the data from the round 1 visit, and advice including a plan of action to be presented to the dairy operator. In addition, to enhance dairy operator compliance, an economic worksheet which assesses quality control programs for mastitis was used to determine tha amount of financial profit and return from adoption of the plan of action. Preliminary results of rounds 1 and 2 plus implications for dairy practitioners will be discussed in this presentation.

Introduction

Mastitis is one of the most costly diseases affecting dairy producers.[1] Recent studies have estimated a loss of $104-$163 per cow per year due to clinical mastitis [2,3]. Clinical mastitis can be treated with a wide variety of antibiotics depending on the type of bacteria involved in the disease process. Antibiotic residues can enter the milk because of drugs used to treat mastitis. An alternative to continued drug treatment is a quality control program for mastitis in which prevention is emphasized through improved milking management.

Effective milking management practices are available [4,5,6,7] which reduce new cases of mastitis, yet the effectiveness and adoption rate of these practices is widely variable.[8,9,10] To date, veterinarians have not had an integrated system to define a dairy operator's mastitis problem and implement a plan which provides management advice to control mastitis. A standardized recording form (instrument) which identifies and provides specific scoring criteria for the most important 46 individual management practices associated with milk quality has been developed and validated.[11,12] The form is referred to as an "instrument" because it measures deviations from normal or optimal practices that are associated with disease or the increased risk of disease. The purpose of this study was to test whether an integrated system of quality control which incorporates information obtained from the scoring instrument is more effective during a farm visit at consistently defining problems causing suboptimal udder health compared to using existing veterinary investigative procedures.

In addition, to enhance dairy operator compliance and adoption of these practices, an economic worksheet which assesses quality control programs for mastitis was used to determine the amount of financial return versus the cost of implementing and monitoring a plan which provides management advice.[13]

Materials and Methods

A convenience sample of 26 Wisconsin dairy farms serviced by 9 veterinarians from 5 veterinary practices were randomly assigned into instrument-advice (IA) and veterinary practice-advice (VPA) categories. These dairies were on a DHI record system, had an adequate milking system, practiced year round calving, and had a herd weighted DHI scc greater than 250,000 over the previous year. Parity was acounted for by accepting only herds within 2 standard deviations of the mean culling rate (33%) and 2 standard deviations of the mean percentage of heifers within a herd (33%) for Wisconsin.

Three bulk tank samples from a three day period were pooled and cultured to provide a microbiological profile of each dairy's udder health. Herds with S.(Streptococcus) agalactiae were excluded from the study because systematic assignment of the study groups will not control for this bacteria's sporadic frequency and variable scc response. This lack of control would then confound results.

Data Collection

Round 1

Farm visits for all dairies included scoring each dairy's milking management practices, recording data on mastitis losses, collecting DHI data and processing plant test results, recording milking time vacuum tracings, and providing a barnsheet to record clinical cases of mastitis. The standardized management scoring evaluated milking procedures, the farm environment, the milking system, treatment and control procedures, and record use. Financial information about clinical mastitis treatments, scc premiums, culling for mastitis, and milk production losses were summarized reflecting financial losses due to mastitis. DHI scc, production, and reproduction data was used to estimate prevalence and incidence of "mastitis" and to provide a mechanism for various sub-population analyses. Processing plant test results over time which included bulk tank scc, standard plate counts, and preliminary incubation counts provided information on milk quality, udder preparation for milking, milking system wash cycle, and milk cooling. Milking vaccum tracings were recorded on two average producing cows in the herd. Measurements include milking vacuum level, vacuum fluctuation at the milk claw, pulsated rate, and pulsated ratio. The barnsheet was used in round 2 to assess clinical mastitis incidence and treatment costs.

The VPA dairies' veterinarians received only the bulk tank culture results and implemented on-farm a plan of action within 30 days based on usual protocol of the veterinary practice given the level of scc, culture results, and history of service to the dairy. The IA dairies' veterinarians received a report sumarizing the herd visit which included: DHI monthly herd summary, bulk tank culture results, processing plant test results, category and question scoring results, DHI scc data summaries, financial losses due to mastitis, and milking system vacuum tracings analysis. This report was discussed at a meeting with the veterinarian and formulated into a plan of action that was presented to the farmer by the veterinarian within 30 days. For both study groups of (IA and VPA) dairies the veterinarian reported back on what changes were implemented (compliance) along with their costs to allow calculation of plan of action costs.

Round 2

Visits to each dairy 6 months after round 1 consisted of collecting the same data as round 1 with the addition of collecting the clinical barn sheet implemented in round 1, as well as recording and documenting plan of action costs. The followup meeting with the IA veterinarian for round 2 consisted of fine tuning the plan of action to achieve compliance. Veterinarians visited each study group farm within 30 days as in round 1 and discussed the plan of action with the dairy operator. The followup for round 2 VPA veterinarians once again only provided bulk tank culture results to be used in the existing protocol for those dairies. Round 3 visits will include collecting the same data as in the previous rounds, continuing to fine tune the plan of action, and summarizing the data on each dairy for all three rounds.

Outcome Measurement

A proxy for mastitis prevalence was calculated for both study groups by estimating the number of cows greater than 250,000 cells/ml at the current test. A proxy for mastitis incidence was calculated for both study groups by identifying those cows with a scc greater than 300,000 cells/ml in the current month and 2 times greater than the previous month's scc. The difference in these values between the first 2 rounds was analyzed with a paired t test and the difference in these values between study groups was analyzed with a z test.

The difference in the herd average linear scc score between the first 2 rounds for each study group was analyzed using a paired t test and the difference between herd average linear scc score between study groups was analyzed using ANOCOVA. Management categories and total score were evaluated to decide if the change from Round 1 to Round 2 was significant. Because of the multiple comparisons the p-value was set at .05/t (.004) where t is the number of comparisons made for each group.[12]

Financial losses from mastitis were estimated from data collected during rounds 1 and 2 to identify the initial losses and any changes in these losses after the initial implementation of the plan of action.

Results

The current study is two thirds completed as all dairies in the study have been scored two times. The prevalence rate for the IA herds was 31% (round1) and

29% (round2), and for VPA herds was 31% (round1) and 27% (round2). The difference in prevalence rates between rounds for each study group and between study groups was not significantly different. The incidence rate for the IA herds was 7% (round1) and 5% (round2) and for the VPA herds was 9% (round1) and 6% (round2). The difference in incidence rates between rounds for each study group and between study groups was not significantly different.

Plans of action have been initiated on all the dairies in the study, and the difference in herd average linear scc score has been calculated for each dairy between round 1 and 2 (Table 1) and the results of the paired t test and the ANOCOVA indicate there is no significant difference in herd average linear scc score between rounds for each study group and between study groups (Table 1).

Table 1. Instrument advice dairies average linear score values for Round 1 and Round 2.

	Round 1 visit	Round 2 visit	Change in linear score	Months between visits
	3.43	3.44	-0.01	6.6
	3.25	3.02	0.23	7.8
	2.97	3.91	-0.94	6.9
	3.14	2.94	0.2	6.7
	3.92	3.48	0.44	8.1
	3.36	3.25	0.11	6
	3.02	2.77	0.25	8.1
	3.88	3.59	0.29	8.1
	2.9	3.13	-0.23	7.9
Mean	3.37^{c}	3.28^{c}	.029^{d}	- LS mean
	Practice advice dairies average linear score values for round 1 and round 2			
	3.18	3.2	-0.02	8
	3.02	3.15	-0.13	7.8
	2.64	2.52	0.12	7.1
	3.75	3.63	0.12	7
	3.74	3.7	0.04	6.9
	2.91	3.46	-0.55	5.9
	3.00	2.82	0.18	7.1
	3.75	3.93	-0.18	6.9
	3.20	2.54	.66	8.1
	3.53	2.63	0.9	7.8
Mean	3.27^{c}	3.15^{c}	.132^{d}	- LS mean

[a] Average of 6 months linear scores previous to Round 1 visit.
[b] Average of 3 months linear scores previous to Round 2 visit.
[c] Within Round 1 and Round 2, means with same superscript are not statistically different (p>0.15).
[d] Within change in linear score, least square means with the same superscript are not statistically different (p >0.15).

The IA management scoring results for round 1 and 2 indicate that the milking system (round 1) and milker performance (round 2) categories had the highest average score indicating the best level of management. Traffic Flow (round 1) and post milking (round 2) categories had the lowest average scores indicating the poorest level of management. Total scores for this study group for round 1 and 2 ranged from 578 to 757 and 602 to 755 out of 920 respectively (Table 2). The results of the individual management category comparisons for this study group indicate traffic flow and milker performance were significantly different between rounds 1 and 2 (Table 2). The average IA dairies' financial losses for mastitis were $106/cow and $112/cow per year for round 1 and 2 respectively. The category breakdown of these losses is presented in Table 3.

Table 2. Summary of time-period effects on category scores within and between study groups IA and VPA)

	Instrument Advice		Practice Advice	
	Round 1	Round 2	Round 1	Round 2
C1	51.8^{a} ± 10	53.4^{a} ± 10	51.6^{a} ± 9	49.2^{a} ± 10
C2	57.1^{a} ± 19	53.6^{a} ± 20	40.7^{a} ± 25	41.5^{a} ± 20
C3	65.8^{a} ± 10	62.9^{a} ± 13	60.7^{a} ± 6	60.3^{a} ± 7
C4	55.1^{a} ± 11	54.1^{a} ± 9	55.5^{a} ± 7	58.0^{a} ± 10
C5	43.7^{a} ± 6	51.4^{b} ± 7	39.7^{a} ± 7	43.4^{a} ± 8
C6	53.6^{a} ± 9	68.2^{b} ± 5	51.0^{a} ± 8	64.7^{b} ± 7
C7	44.6^{a} ± 13	48.4^{a} ± 11	47.0^{a} ± 14	43.4^{a} ± 11
C8	57.2^{a} ± 11	62.1^{a} ± 11	59.7^{a} ± 11	56.1^{a} ± 12
C9	45.1^{a} ± 11	46.0^{a} ± 7	44.9^{a} ± 11	43.5^{a} ± 9
C10	59.5^{a} ± 9	63.4^{a} ± 6	64.6^{a} ± 8	66.9^{a} ± 7
C11	53.0^{a} ± 9	52.4^{a} ± 8	51.8^{a} ± 7	56.9^{a} ± 8
C12	54.0^{a} ± 9	59.3^{a} ± 10	59.3^{a} ± 8	64.5^{a} ± 6
TOTAL	640.6^{a} ± 51	675.2^{a} ± 45	625.8^{a} ± 85	648.4^{a} ± 64

[a,b] Within each row and study group, means with the same superscript are not statistically different (p>0.05/12).

Table 3. Average losses per cow due to mastitis in excess of goal for each study group (IA and VPA).

	Instrument Advice		Practice Advice	
Losses	Round 1 (range)	Round 2 (range)	Round 1 (range)	Round 2 (range)
Clinical cases	$3.41 (0-10.75)	$2.99 (0-10.14)	$6.97 (0-21.55)	$6.87 (0-23.35)
Milk production	$34.29 (10.46-73.70)	$41.42 (11.32-106.06)	$35.93 (20.12-60.00)	$43.21 (8.74-82.35)
Replacements	$21.37 (0-72.97)	$21.10 (0-85.09)	$31.30 (0-81.41)	$32.58 (9.05-88.20)
SCC premiums	$47.19 (15.50-90.76)	$46.59 (0-124.11)	$40.22 (9.45-79.17)	$31.98 (0-58.15)
TOTAL	$106.26 (57.81-182.59)	$112.10 (22.46-243.96)	$114.41 (51.75-175.43)	$114.65 (17.78-192.95)

The VPA management scoring results for round 1 and 2 indicate that the mastitis treatment category had the highest average score indicating the best level of management. Traffic Flow and milking machine maintenance categories had the lowest average scores indicating the poorest level of management respectively. Total scores for this study group for rounds 1 and 2 ranged from 519 to 800 and 566 to 792 out of 920 respectively (Table 2). The results of the individual management category comparisons for this study group indicate that the milker performance category was significantly different between rounds 1 and 2 (Table 2). The average VPA herds' financial losses for mastitis were $114/cow and $115/cow for rounds 1 and 2 respectively. The preliminary benefit is $2/cow. The category breakdown of these losses is presented in Table 3.

Discussion

This study was viewed from the beginning as a pilot study to develop the study design and analytical methods for conducting clinical research that assesses problem-identification and compliance issues in solving mastitis problems. A major study design issue which arose in this study was the selection of herds. Dairies had to be removed from the study because of being classified grade B which designated a different set of minimum standards for their operations compared to grade A. Also, each veterinarian-dairy operator relationship was different to the extent that during the study period some veterinarians' service changed from regular monthly visits to emergency only visits which compromised implementation of plans of action.

Herds with S. agalactiae were excluded as indicated above to avoid confounding the results of the analyses. The removal of dairies for grade and S. agalactiae presence reduced the number of dairies to 19 for analysis. This action increased the potential for a type 2 error because of a lack of statistical power. The results to some degree reflected this potential as a number were not significant. Future studies through power calculations in the planning of their study design should attempt to enroll the largest sample size the budget will tolerate.

The instrument has been validated in terms of tracking changes in management that reveal improving or declining udder health over time.[12] This was repeated to some degree in that 2 management categories changed significantly in both study groups (IA and VPA) between rounds 1 and 2. On one hand, this result may be further evidence for the lack of statistical power. On the other hand, having similar categories being significant between rounds 1 and 2 does support the study design protocol in that both study groups are comparable.

The success of solving a multi-factorial disease problem such as mastitis is dependent on a change in management performance. As of round 2 the average linear scc score was not significantly different between study groups. This result is not suprising in view of the fact that the relationship between management practices and udder health is difficult to model over time.[12] In addition, the proxies for prevalence and incidence for both study groups are not significantly different either. The authors speculate that there is a lag between when the problem was defined, the plan of action initiated, and when various stages of implementation have begun. This is not only time dependent (round 3 is not completed) but dependent on the type of bacteria causing the problem i.e., an environmental versus a contagious pathogen require a much different scale of solution.

The compliance of the dairy operator in implementing the plan of action is the most critical factor in the success of this research. Probably the most important ingredient of compliance is having a motivated dairy operator. This was not part of the entry requirements of this trial. Future studies such as this need to take into consideration social-psychological characteristics of the dairy operator, as a recent study identified matters such as education, days of off-farm work, number of dependents, and even attitudes, aspirations, and self concepts were linked to milk production.[14] The integrated quality control system that is being tested is an application of a disease surveillance system in a production environment. This is also an important ingredient concerning compliance in that progress has to be monitored in a "connected manner" i.e., connected to the dairy operator's management system. The connection that this study is attempting to measure is the profit and return from the implemented management changes resulting from the plan of action. Thus as plans of action are being refined as the study approaches round 3 the dairy operator is being motivated to make changes based on financial measures not biological measures.

One of the challenges in clinical problem-solving facing veterinarians in mastitis investigations is the ability to integrate data from multiple sources with a disease with multiple causes. The challenge is one of problem definition in that veterinarians attempt, in their efforts to resolve a mastitis problem, to integrate the management factors responsible for the frequency of the bacteria present either on the farm or cow environment with factors responsible for the pathogenesis. The hope is that this instrument can address the above challenge as a standardized recording form to measure actual management performance. To the extent that it does this, it becomes a clinical instrument measuring deviations from normal or optimal practices that are associated with suboptimal udder health or the increased risk of it.

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Clinical Field Trial for Remote Radio Telemetry Heat Mount Detection System

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Abstract

Accurate and efficient estrus detection is required to maintain reproductive performance in an artificially inseminated herd. Even with a substantial labor commitment, visual estrus detection is not practical in a large, multi-unit herd given the diurnal pattern of estrous behavior. Large dairies increasingly elect to reduce labor costs by relying on less accurate detection methods, eg. tail chalk, or by eliminating genetic improvement of youngstock from the operation mission.

A commercial heat mount detection system (HMDS) was evaluated for accuracy of estrus detection. The system was used to monitor behavioral estrus in 130 cows. HMDS was compared with visual observation and biweekly radioimmunoassay of milk progesterone.

The study was conducted on Holstein cows at a commercial dairy in Colorado from December 1991 to September 1992. Cows were confined in groups of 200 to an uncovered free-stall area and allowed onto an open dirt lot if weather conditions permitted. Expermental animals were mature cows producing greater than 85 lbs of milk per day on three times a day milking. Cows were eligible for enrollment into a study group based on a normal post-partum rectal palpation and more than 29 days in milk. HMDS patches were fitted to the tailhead of all cows at enrollment. Visual heat detection took place twice daily for half an hour at varying times of day depending on season and weather condition. Tail chalk was applied daily and HMDS patches were evaluated for attachment and replaced as needed on a daily basis. Visual data collected included standing, bulling, loss of tail chalk, mucoid and bloody discharges, and restlessness or bellowing. Milk samples were collected twice weekly from the time of enrollment until the cow was confirmed pregnant or removed from the pen due to decreased production. Progesterone (P4) analysis by radioimmunoassay (Niswinder, 1973) was performed by the Animal Reproduction Laboratory at Colorado State University.

Physiological estrus was defined as P4 less than 1 ng/ml or decreased by five-fold in magnitude from the previous diestrual peak. HMDS criteria for estrus were greater than or equal to 4 recorded mounts in 24 hours. Visually detected estrus was defined as standing to be mounted.

Sensitivity and specificity of the device, data recording capabilities and other details of the trial will be presented.