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An Evaluation of a Treatment Protocol for Intramammary Infections in Early Postpartum Dairy Cows Based on a Positive California Mastitis Test Result

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Abstract

Recent studies have evaluated the use of the California Mastitis Test (CMT) in early postpartum cows to identify intramammary infections (IMI). Whether the CMT is used to identify cows for culture or for herd-level udder health monitoring, many producers are in a dilemma when faced with a positive CMT result. The purpose of the study was to evaluate the effectiveness of an intramammary treatment protocol based on a positive CMT result within the first three days of calving. In addition, the effect of early intramammary antibiotic therapy on cure rates, linear somatic cell score (LS) and milk production for the first three Dairy Herd Improvement (DHI) tests post-calving was assessed. A total of 1861 quarters, representing 561 cows from 24 commercial herds, were enrolled. All quarters from each cow were tested by the dairy producer using the CMT, and sampled aseptically for milk bacteriology between calving and three days-in-milk (DIM). Cows with a positive CMT (n=180) were randomly assigned to receive either intramammary (IMM) cephapirin sodium, or no treatment. A CMT with any reaction was considered positive. All CMT-positive cows were sampled for bacteriological culture between 10-16 DIM to determine cure of infections. Cure rates were evaluated using data from 138 treated and 117 control quarters. Cure rates for all major pathogens for the treated and control group were 84.6 and 71.7%, respectively. This difference was not statistically significant. However, cure rates for environmental streptococcal infections for the treated and control group, 89.4 and 70.82%, respectively, were statistically different (P=0.05). Cows that cured a major pathogen had a decrease in linear score. As LS decreased, milk production increased. When milk production was evaluated, it was demonstrated that as the CMT score increased, cows had a 4.6 lb (2.1 kg) decrease in milk production per test date. The antibiotic treatment groups were not significantly different for LS or milk production by the third test date. In conclusion, this fresh cow protocol was most effective to reduce IMI due to environmental streptococci and reduce LS. Therefore, blanket therapy of all CMT-positive cows may not be justified. Udder health status and predominant mastitis pathogen within the herd need to be considered when developing treatment protocols.

Résumé

Des études récentes ont évalué l'utilisation du Test californien de la mammite (CMT) chez des vaches tôt en post-partum pour identifier les infections intramammaires (IMI). Que l'on utilise le CMT pour l'identification de vaches pour la culture ou pour la surveillance de la santé du pis au niveau du troupeau, plusieurs producteurs font face à un dilemme lorsque le résultat du test est positif. Le but de l'étude était d'évaluer l'efficacité d'un protocole de traitement basé

sur un résultat positif au CMT dans les trois premiers jours suivant le vêlage. De plus, on a évalué l'effet d'une thérapie antibiotique intramammaire précoce sur le taux de guérison, le score linéaire du comptage des cellules somatiques et la production de lait durant les trois premiers tests du contrôle laitier suivant le vêlage. Un total de 1861 quartiers, représentant 561 vaches provenant de 24 troupeaux commerciaux, ont été suivis. Tous les quartiers de chaque vache ont été examinés par le producteur avec le CMT et ont été échantillonnés aseptiquement pour la bactériologie du lait entre le vêlage et les trois premiers jours en lait (DIM). Les vaches avec un CMT positif (n = 180) ont été alloués aléatoirement à un groupe recevant une infusion intramammaire de céphapirine sodique ou à un groupe témoin sans traitement. Tout CMT avec une réaction était considéré positif. Toutes les vaches positives ont été échantillonnées pour la culture bactériologique entre les jours en lait 10 et 16 pour déterminer la guérison des infections. Le taux de guérison était évalué avec les données provenant de 138 quartiers traités et 117 quartiers témoins. Le taux de guérison pour tous les agents pathogènes majeurs était de 84.6% et de 71.7% pour le groupe traité et le groupe témoin, respectivement. Cette différence n'était pas statistiquement significative. Toutefois, le taux de guérison pour les infections environnementales à streptocoques était plus élevé dans le groupe traité que dans le groupe témoin (89.4% versus 70.82%; P = .05). Suite à l'éradication d'un pathogène majeur, les vaches présentaient une baisse du score linéaire. La production de lait était accrue lorsque le score linéaire diminuait. Suite à l'évaluation de la production laitière, on a démontré que lorsque le score du CMT s'accroissait, il y avait une baisse de production de lait de 2.1 kg (4.6 lb) par jour de test. Le groupe traité ne se distinguait pas du groupe témoin en termes de score linéaire et de production laitière à la troisième évaluation. En conclusion, le protocole précoce était surtout effectif au niveau de la réduction des streptocoques environnementaux et de la réduction du score linéaire. Par conséquent, la thérapie universelle pour l'ensemble des vaches avec des tests CMT positifs n'est peut être pas justifiée. Il est important de considérer l'état de santé du pis et la prédominance des pathogènes de la mammite prédominants dans le troupeau lors du développement de protocoles de traitement.

Introduction

Reducing intramammary infections (IMI) in early lactation may have significant economic benefits for the dairy operation.[5,9,11] Over half of new infections at calving are acquired during the dry period and persist into lactation.[3,20] Treatment of IMI during the immediate postpartum period, before the milk is saleable, may decrease the amount of discarded milk and ultimately lead to reduced bulk-tank somatic cell counts (SCC). Consistent and reliable methods to determine IMI in early lactation have yet to be identified. Bacteriological culture is the standard method for determining the causal pathogens. However, it is costly to culture all fresh cows. Furthermore, the lag time for results render cultures to be impractical for implementation of a therapeutic protocol of specific cows. In many situations, treatment decisions for IMI should be performed immediately upon detection.

The California Mastitis Test (CMT) is a surrogate measure for SCC in milk, and is a rapid cow-side test for subclinical mastitis. The early research to establish the CMT test characteristics was developed in herds with mastitis problems and from cows that were not in early lactation.[8,18] More recently, the CMT has been used to identify potential IMI in the first 10 days post-calving.[16] This study demonstrated that the optimum sensitivity and specificity of the CMT to select infected quarters for culture was at three days post-calving. Similar work in the Netherlands support these findings.[1] In addition, in a study on colostral milk, it was determined that CMT was a useful test to indicate an increased SCC, and thus identify an IMI in the early postpartum period.[10]

It has been stated that because of less than ideal sensitivity (82.4%) and specificity (80.6%), the CMT has limited use for making individual cow decisions.[4] Rather it may be more useful to predict the percentage of IMI in fresh cows for herd-level monitoring of udder health programs, such as the assessment of dry-cow management programs. Regardless, many producers are in a dilemma when faced with a positive CMT result in fresh cows. Knowledge of the pathogen prior to any treatment protocol is ideal, but not always realistic.

There has been much debate on the importance of antibiotic therapy for IMI early in lactation. Due to the spontaneous cure rates of some infections, many producers do not treat these IMI early postpartum.[6] However, it also has been reported that early detection and intervention of IMI with antibiotics is an effective method to achieve cure.[7] Many mastitis treatment studies have focused on the treatment of clinical mastitis throughout lactation, and not in fresh cows. The implications of antibiotic treatment of IMI in the early postpartum period on cure rates, reoccurrence rates and milk production later in lactation are not well documented. A recent study evaluated the response to therapy with intramammary (IMM) cephapirin sodium on CMT positive quarters in fresh cows on cure rates and SCC.[15] It was determined that by the 4-week post-calving evaluation, quarters treated with cephapirin sodium had significantly increased cure rates and somatic cell counts

were significantly reduced compared with untreated control quarters.

It is hypothesized that early detection and treatment of intramammary (IMI) could be an effective procedure as a component of a mastitis control program in selected dairy herds. The purpose of our study was to evaluate the impact of IMM treatment protocol based upon the CMT results in fresh cows. The effects of IMM therapy on bacteriologic cure rates, as well as milk production and LS were evaluated.

Materials and Methods

Herd selection and sampling time line

From September 2000 to April 2001, commercial dairy herds from southwestern Quebec (n=14), central Ontario (n=2) and New York State (n=8) enrolled fresh cows in the field trial. Herd size in the Canadian herds ranged from 35 to 160 cows, and from 40 to 1500 cows in the New York herds. Herds were purposively selected based on their enrollment in regular Dairy Herd Improvement (DHI) testing program, convenience of location and willingness to participate. First lactation and multiparous cows were enrolled immediately after calving. The dairy producer performed the CMT on foremilk quarter samples for each postpartum cow, between the day of calving and day three in milk. The dairy producers were trained to perform and interpret the CMT prior to study initiation. The producers scored the CMT reaction according to an established scoring method.[18] The CMT reaction was scored as either 0, 1, 2, or 3, with zero indicating no reaction. Trace reactions were scored as 1. A score of 1, 2, or 3 was considered a positive CMT reaction. Quarter milk samples were aseptically collected from all functional quarters at the time of enrollment when CMT testing was conducted, according to the National Mastitis Council (NMC) guidelines.[13] From the Canadian sites, calculations of the CMT test characteristics were performed using the milk bacteriological culture result as the gold standard as a separate objective to the study.

CMT positive cows were then allocated to one of two treatment groups. Cows were randomly assigned to receive either 200 mg of IMM cephapirin sodium,[a] two IMM treatments at a 12 hour interval as per label instructions, or no treatment. Randomization of cows to the treatment groups was performed using even-odd assignment sequentially following calving. For the antibiotic treatment group, if a cow was CMT positive in two or more quarters, all quarters received antibiotic treatment. All CMT positive cows also had quarter milk samples aseptically collected for bacteriological evaluation on two more occasions (10-16 DIM, and 17-23 DIM) to determine cure of infections. Individual cow DHI data for the first three DHI test dates were obtained. The DHI data consisted of test day milk (kg) and SCC.

Bacteriological procedures

Samples were frozen and shipped to the Mastitis Research Laboratory at the University of Guelph or to Quality Milk Production Services (QMPS) at Cornell University. Each laboratory had standard operating procedures in place for the handling of samples, culture techniques, and interpretation of results consistent with NMC recommended procedures.[13] The laboratory staff were blinded to treatment group allocation. An inoculum of 0.01 ml of milk was plated onto Columbia base agar containing 5% sheep blood. Plates were incubated at 98.6°F (37°C) and examined for bacterial growth at 24 and 48 hours. Colonies were tentatively identified as species of staphylococci, streptococci, coliform, or other pathogens based on colony growth, morphology and appearance, pattern of hemolysis, catalase reaction, and Gram staining. Staphylococcal isolates were tested for coagulase production with the tube coagulase test. Streptococcal isolates were further subcultured with agar containing esculin. Gram-negative bacteria were plated on MacConkey agar to facilitate identification. Gross appearance and reaction to citrate were used to differentiate *Escherichia coli* and *Klebsiella* sp. For each positive quarter, the number of CFU per 0.01 ml milk was reported in one of four categories: 1 to 5, 6 to 10, 11 to 50 or ≥ 50 CFU. A quarter was considered infected with coagulase-negative staphylococci (CNS) if greater than or equal to 11 CFU per 0.01 ml were isolated. The isolation of CNS was reported when the organism grew with another pathogen. A sample was considered contaminated if three or more colony types were present on a plate. Since all samples were frozen, quarter SCC determination was not performed. In the QMPS laboratory all procedures were similar except that differentiation of esculin positive or negative streptococcal isolates was not performed.

Statistical analysis

Data generated from quarter milk cultures, CMT scores, and individual cow DHI records were stored in Microsoft Access (Microsoft, Access 2000) and Microsoft Excel (Microsoft, Excel 2000) databases. Herd data from all sites was combined and imported into SAS version 8.01 for analysis. Descriptive statistics were generated using the univariate and frequency procedure in SAS.[17] Differences in cure rates were tested with a chi-square (c^2) analysis. Logistic regression for cure or no cure for each organism was modeled by fitting a generalized linear model. Since quarters within a cow are not independent, correlation within cows was accounted for using generalized estimation equations with a compound symmetry correlation structure.[2] Cures were analyzed by quarter, while the unit of concern for milk production and linear score was the cow. Milk production and the natural log of the SCC (lnSCC) were analyzed using lin-

ear models. Variables in the model included herd, parity, days-in-milk, and the study covariates of mean CMT score, cure of a major pathogen and treatment.

A minor infection was defined as greater than 10 colony-forming units of CNS, or *Corynebacterium bovis* being isolated on culture. An IMI due to major pathogen was defined as the presence of any other pathogen except those included in the minor pathogen category.

To assess the effect of CMT score, a mean CMT variable was created. The mean CMT is the mean of the quarter CMT scores for that cow. The impact of CMT score treatment group, and cure were assessed by measuring changes in ln(SCC) and milk production using a mixed model procedure, controlling for herd, breed, lactation and test date.

Cure rates were assigned based on one follow-up milk bacteriologic culture result. A cure was assigned if the follow-up quarter sample was negative for the initial pathogen. According to the initial protocol, a second follow-up quarter culture between 17-23 DIM was required. Due to the extensive nature of the experiment conducted at the Canadian study sites, it was not possible for a technician to visit the farms to collect follow-up samples. As a result, only 48% of cows had both follow-up milk cultures. Therefore, it was decided that cure rates would also be based upon the results from a single postpartum milk culture.

Statistical significance was declared at $P < 0.05$. All biologically plausible two-way interactions were tested. The estimated regression parameters were converted to odds ratios.

Results

The total number of cows enrolled in the CMT study was 585 cows with 2112 quarters. After excluding cases where protocol was not followed (n=10), where any other antibiotic treatment was administered, or where either CMT or initial culture data was missing, as well as excluding contaminated quarters, 1861 quarters, representing 561 cows, were available for analysis. There were 180 CMT positive cows (255 quarters) randomized to the fresh cow treatment protocol. The percentage of quarters sampled at the day of calving, day 1, day 2 and day 3 in-milk were 16.6, 51.0, 21.7 and 8.9%, respectively. Quarters of cows that were outside this sampling time frame were excluded. The percentage of cows that were in their first, second and third and greater lactation were 37.0, 29.7 and 33.3%, respectively. Although Holsteins represented the majority of the sample population in the study (89%), Ayrshires (7.1%) and Jerseys (3.8%) were also enrolled. Herd prevalence of IMI ranged from 2 to 26% of cows infected with a major pathogen, as determined by bacteriologic culture. The distribution of the CMT scores 0, 1, 2 and 3 was 74.8, 10.6, 8.1, and 6.4%, respectively.

The bacteriological results from all quarter samples (n=2112) at freshening (0-3 DIM) are as follows; major pathogens were cultured from 11.9% (n=294) of the samples, minor pathogens represented 12.1 % (n=299), while 49.1% and 16.4% yielded non-significant bacterial growth and no growth, respectively. There were 9.4% of samples considered as contaminated. The most common bacterial pathogen isolated were the coagulase-negative staphylococci (42.7%). Among the major pathogens, environmental streptococci spp were the most prevalent, representing 46.6% (n=137). In quarters infected with an IMI, *Staphyloccus aureus, E. coli* and *Klebsiella* represented 11.1 (n=66), 5.7 (n=34) and 4.7% (n=28) of the major pathogens, respectively.

As stated earler, calculations of the CMT test characteristics were previously reported.[22] This study reported that the overall sensitivity and specificity of the CMT for major pathogens was 57.6 and 85.3%, respectively.

The effect of IMM antibiotic treatment of CMT positive quarters on cure of pathogens was analyzed. The bacteriological results from 255 quarters available for cure rate analysis and the results for the probability of cure of IMI are shown in Table 1. In quarters infected with a major pathogen, 66/78 (84.6%) quarters cured on follow-up cultures. In the no-treatment group, 38/53 (71.7%) quarters had spontaneous cures of these postpartum infections. This difference was not statistically significant (P=0.07).

In quarters infected with a minor pathogen, treated and non-treated quarters had a cure rate of 80% (48/60) and 76.6% (49/64), respectively. This difference was also not statistically significant. However, quarters infected with environmental *Streptococci* that were treated with IMM antibiotics had an 89.4% (42/47) cure rate, while only 70.8% (17/24) of quarters had spontaneous cures. This difference was statistically significance at P=0.05. When correcting for within-cow clustering, the significance level for cure of all major pathogens changed to 0.05, whereas for environmental streptococci it changed to 0.08.

Factors influencing lnSCC in CMT positive cows were evaluated (Table 2). Cows that cured a major pathogen had a significant decrease in lnSCC (P=0.03). The mean CMT score at calving did not effect test day lnSCC. Differences in SCC varied widely among herds. The effect of treatment on mean CMT score was tested, but found not to have any significant effects.

The results for the milk production analysis are illustrated in Table 3. The results indicated that for every unit increase in the lnSCC, there was a reduction in milk production on the third DHI test (P=0.02). Similarly, as the mean CMT score at calving increased, cows produced 4.6 lb (2.1 kg) less milk on the third DHI test (P=0.04). First and second parity cows had significantly

Table 1. Cure rates for 180 positive CMT cows (n=255 quarters), as sampled within the first three days of lactation, and that either received intramammary sodium cephapirin or no treatment.

		Treatment IMM Cephapirin		No treatment		
Pathogen isolated	Total Quarters*	N	(%)	N	(%)	*P* value
Major	**131**	**66/78**	**(84.6)**	**38/53**	**(71.7)**	0.07
Staphylococcus aureus	9/12	(75)	10/15	(66.7)	0.64	
Environmental streptococci**	42/47	(89.4)	17/24	(70.8)	0.05	
Escherichia coli	14/14	(100)	9/10	(90)	0.23	
Klebsiella	5/7	(71.4)	4/5	(80)	0.73	
Other coliforms	1/1	(100)	-	-	-	
Other**	4/6		5/6			
Minor	**124**	**48/60**	**(80.0)**	**49/64**	**(76.6)**	0.64
Coagulase negative Staphylococci	41/53	(77.4)	37/52	(71.1)	0.47	
Corynebacterium bovis	7/7	(100)	12/12	(100)	-	

*Total pathogen growth greater than n=255 due to some quarters growing multiple (but <3) pathogens.
**Includes *Streptococcus dysgalactiae, Streptococcus uberus,* and other *Streptococci.*
***Includes Yeast (1), Mold (5), *Pseudomonas* (3), *Proteus* (3), Prototheca (1), Serratia (1), *A. pyogenes* (1).

Table 2. The influence of various factors on linear score measured on the first three DHI test dates after calving.

Parameter	*B* estimate	Standard error	*P* value
Intercept	5.40	0.36	<0.001
Trial site A[1]	-0.04	0.30	0.91
Trial site B[1]	0.00	-	-
Test date 1	0.29	0.17	0.08
Test date 2	-0.15	0.17	0.37
Test date 3	0.00	-	-
Cure of major pathogen[2]	-0.76	0.35	0.03

[1]Trial sites A and B correspond to study herds in the NY area and Quebec-Ontario, respectively.
[2]Any major environmental or contagious pathogen isolated within the first three days of calving, not isolated in a follow-up sample (10-16 DIM) after treatment.

Table 3. The influence of covariant factors on kilograms of milk measured on the first three DHI test dates after calving.

Parameter	*B* estimate	Standard error	*P* value
Intercept	36.1	4.3	<0.0001
Trial site A[1]	5.93	1.68	0.0005
Trial site B[1]	0	-	-
Ayrshire	-0.77	4.1	0.87
Holstein	9.0	4.1	0.02
Jersey	0	-	-
Parity 1	-8.89	1.3	<0.0001
Parity 2	-4.07	1.4	0.005
Parity >=3	0	-	-
Test date 1[2]	-1.7	0.57	<0.003
Test date 2[2]	-0.28	0.56	0.62
Test date3[2]	0	-	-
lnSCC	-0.58	0.25	0.02
Mean CMT at calving[3]	-2.1	0.98	0.04
Treatment[4]	-1.4	1.5	0.35
Treatment*Trial site A[5]	-1.18	2.3	0.61
Treatment*Trial site B[5]	0	-	-

[1]Trial sites A and B correspond to study herds in the NY area and Quebec-Ontario, respectively.
[2]The first three monthly DHI tests after calving.
[3]The mean CMT score from quarters tested with the CMT within three days of calving.
[4]Cows that received intramammary cephapirin sodium (Cefa-Lak, Ayerst Laboratory, Guelph, Ontario, Canada).
[5]The interaction effect of intramammary cephapirin sodium in study sites.

less milk than the third and greater parity group. Cows also produced less milk on the first test date compared to the third test date (P=0.003). Breed differences in milk production were also significant. In addition, there were significant differences in milk production between the two study sites. IMM antibiotic treatment did not have a significant effect on milk production, nor was there a significant effect of treatment between the different trial sites. Futhermore, curing a major pathogen had no significant effect on milk production once cell count was accounted for.

Discussion

The CMT has historically been used as a cowside screening test for subclinical mastitis during lactation.[8] Several recent studies have shown that the CMT may be a valuable tool for detecting IMI in the early postpartum period.[4,16,22] Some companies have promoted the use of these fresh cow protocols based on CMT results.[14] Consequently, there was a need to evaluate fresh cow treatment protocols based on CMT results. The objective of this study was to determine the efficacy of a protocol using IMM therapy of CMT positive quarters, and its impact on milk production and linear score.

There was a high percentage of environmental streptococci isolated at calving, representing 46.6% of major pathogens. There was also a marked difference among herds in the prevalence of major IMI at calving. However, a direct comparison of the frequency of IMI between studies is complicated due to differences in the definition of a positive sample.

There was no difference in cure rates for IMM antibiotic-treated quarters for major pathogens (P= 0.07) compared to the untreated controls. However, there was an advantage for cure rates using antibiotics against environmental streptococcal infections. Quarters with streptococci infections were 3.5 times more likely to cure if treated with sodium cephapirin (P= 0.05). It has been reported that early antibiotic treatment of streptococci decreases clinical mastitis relapses and reoccurrences later in lactation.[12,21] In herds where environmental streptococci are the predominate cause of IMI at calving, early antibiotic therapy may be justified. There was no significant difference in cure of CNS infections with antibiotic treatment versus no therapy. This has been demonstrated in previous work.[24] Cows that cured a major pathogen had a lower LS (P=0.03) compared to non-cured cows. This parallels work from a similar study, where they demonstrated that quarters treated with cephapirin sodium had significantly increased cure rates, and significantly reduced SCC (P<0.05) compared with untreated control quarters.[15] These differences could be economically important in achieving premium payments for low SCC milk. A full economic analysis is needed, but is not within the realm of this paper.

In order to have treatment outcome consistent, cure rates were based on only one follow-up sample between 10-16 DIM. As mentioned previously, this was due to a low percentage (48%) of cows having both follow-up samples. Therefore, cure rates for the pathogens may be overestimated because of the collection of just one follow-up sample. This is especially true for *S. aureus* which has an intermittent and cyclical shedding pattern.[19] However, considering this was a field study, the inclusion of some chronic cases as initial IMI may have decreased the cure rates. Our gold standard for cure was a negative culture on a single milk sample. A more appropriate gold standard would have been duplicate or multiple samples with two or more follow-up samples.

The producers were not blinded to the allocation of treatment, therefore strict adherence to random assignment to the antibiotic treated group and the non-treated control group may not have been followed, and could have been biased by individual cow factors. There is a natural tendency to use antibiotics on more severe cases (high CMT scores) and no treatment on milder cases. The authors excluded cows (n=10) that were determined to be non-randomized from the enrollment data. There is still a small discrepancy in the numbers of animals in each treatment group because the cows were randomized by herd with all herds starting with the same treatment.

LS from individual cows were used in our analysis. Analyzing herd SCC during the trial period was not performed because the herd effect of treatment is lost when both treatment and controls are within the same herd. In practice, monitoring herd SCC over time, when all cows are on the same protocol, may be one way to demonstrate the effectiveness of the protocol implemented in that herd.

The cure of a major pathogen in the fresh period did not significantly alter milk production. It may have been more appropriate to use daily milk weights. The use of DHI test day milk production may have masked any short-term changes in milk production due to resolution of IMI.

The results from this trial indicated that curing a major pathogen, either through antibiotic treatment or spontaneously, results in a decrease in LS. It is noteworthy that no one mastitis treatment protocol can be applied to all herds. Udder health status and predominant mastitis pathogen should be considered when developing treatment protocols. Only gram-positive pathogens are considered appropriate for the antibiotic therapy used in this trial. Consequently, blanket treatment of all CMT positive cows is probably not justified in all herds. This approach is also mindful of current issues surrounding prudent use of antimicrobials, as well as the production of quality milk. Given the less than ideal test characteristics of the CMT, milk samples from CMT positive quarters should be aseptically collected for bacteriologic culture. A rapid and accurate method for determining the type of pathogen would benefit producers. Until this time, producers are faced with real time treatment decisions in fresh cows. In the current study, clinical mastitis and relapse rates were not followed into lactation. Future studies should focus on this aspect.

Conclusion

Overall, there was no significant difference in cure rates of IMI due to major pathogens with early IMM

antibiotic treatment compared to untreated controls. However, cure rates for environmental streptococci were statistically significant. Curing a major pathogen resulted in a decrease in linear score by the third test date. In addition, for every one point increase in the mean CMT score at calving, cows experienced a decrease of 4.6 lb (2.1 kg) of milk per test date. Treatment of CMT positive quarters had no significant effect on DHI test date milk production. There still remains the need for economic analysis of the IMM antibiotic treatment protocol of CMT positive quarters. In addition, it is clear that a valuable addition to the decision-making in this treatment protocol for fresh cows would be a rapid inexpensive test to identify the major pathogen group in CMT positive quarters.

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Footnote

[a]Cefa-Lak, Ayerst Laboratory, Guelph, Ontario, and Cefa-Lak, Fort Dodge, IA, USA

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