Decision-Making for Early Postpartum Subclinical Mastitis

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INTRODUCTION

Treating subclinical mastitis during lactation remains a complex decision because economic benefits depend on several factors such as probability of cure, treatment cost and consequent losses in sealable milk (Swinkels et al, 2005). It can be hypothesized that treatment of subclinical mastitis would be economically feasible in certain situations (e.g., when milk prices are high or when there is a potential for prevention of future clinical cases or spreading of contagious pathogens in the herd). However, little research has been conducted to support on-farm early postpartum treatment decisions based on economic outcomes. Sargeant et al, (2001) reported that sensitivity and specificity of the California Mastitis Test (**CMT**) used to detect IMI during the first week of lactation varied greatly by DIM. Therefore, day of testing and test characteristics are important factors that have to be considered when analyzing economic benefits of IMI treatment. The primary **objective** of this study is to evaluate the decisions of detecting and treating subclinical mastitis during the early postpartum period based on their probabilistic economic outcomes.

MATERIALS AND METHODS

Decision Tree Model

A decision tree model was developed to study the economic outcomes of testing and treating early postpartum dairy cows for subclinical mastitis. The model is cross sectional, in which decisions are made in a sequential manner and economic outcomes are evaluated in a 305-d standard lactation. The key dairy producer decisions modeled were: (1) whether to test for subclinical mastitis infection; (2) if no test is decided, what are the potential economic losses due to subclinical mastitis; (3) if test is pursued, which CMT threshold to use; (4) after test is selected, what are the test results; and (5) what actions to take depending on test results according to the true infected status and according to the probability of spontaneous cure (Fig. 1). The structure of the model had 3 sequential decision nodes (squares): (1) test decision, (2) type of test decision, and (3) treatment decision; 3 chance nodes (circles): (1) test results, (2) true infected status, and (3) probability of spontaneous cure; and final outcomes (triangles).

The model compares the option to test with the option of don't test for subclinical mastitis using the CMT test during the early postpartum period (1, 2 and 3 DIM). Sensitivity and specificity of CMT thresholds of 1 (trace), 2 (weak positive) and 3 (strong positive) were based on the data reported by Sargeant et al. (2001).

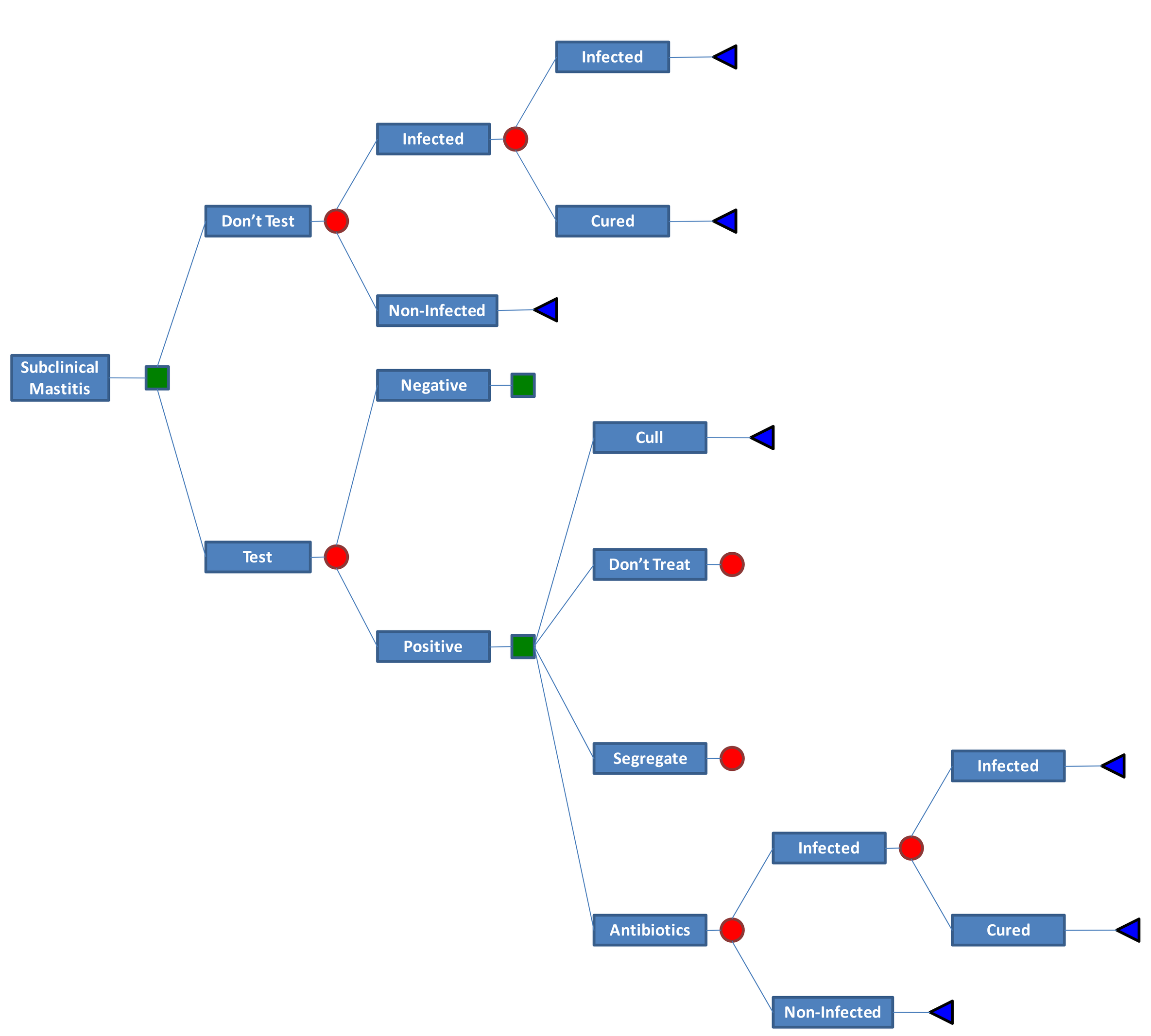

Figure 1. Simplified diagram of early postpartum subclinical mastitis decision tree model

MATERIALS AND METHODS

Each event in the decision tree is associated with an economic outcome that multiplied by its probability of occurrence estimates the relative value of each event resulting from a decision.

Decision Tree Solution

The model uses a process called "averaging out and folding back." This procedure calculates the economic outcomes of each branch of the tree, which then is used to find the optimal (maximum) pathway also called "policy suggestion." Therefore, for each potential outcome of test result (positive or negative), the model selects the optimal treatment (i.e., that one with largest economic value). The producer potential decisions depending on test results included: (1) cull the cow, (2) manage the cow to not spread mastitis (segregate), (3) administer medicines in an attempt to cure subclinical mastitis (antibiotics), or (4) take no action (don't treat). Each intermediate or final node of the model had an economic outcome associated with the probabilities of reaching each branch of the tree. Consequently, the decision tree was able to find the economic optimal pathway for each branch and for the entire decision tree. PrecisionTree® v. 5.0.0 (Palisade Corporation, Newfield, NY) was used to set up the model and analyze the problem of testing and treating subclinical mastitis in early postpartum.

Assessment of the Costs of Decisions Associated with Subclinical Mastitis

There are three levels of costs associated with subclinical mastitis: (1) the costs of performing a test, if any; (2) the cost of doing a treatment, if any; and (3) the cost associated with the subclinical mastitis infection.

Table 1. Characteristics of the base herd and baseline economic values used in the early postpartum subclinical mastitis decision tree model

Parameter	Base Value	Range Values
Cost of a California Mastitis Test ($/cow)	0.8	0.5-2.0
Parity	—	Primiparous - Multiparous
Test DIM	2	1 - 3
Herd mastitis prevalence (%)	30	0 - 60
Contagious pathogens prevalence (%)	5	0 - 20
Transmission factor (cow/d)	0.0244	0.028 - 0.46
Antibiotic treatment cure (%) primiparous	60	40 - 80
Antibiotic treatment cure (%) multiparous	35	20 - 50
Spontaneous cure (%)	50	25-85
Value of milk recovered after antibiotics (%)	0	0 - 70
Segregation cost ($/d)	0.2	0 - 1
Penalty because high SCC ($/kg)	0.024	0.01 - 0.38
Premature culling because of mastitis (%)	5.3	1.78 - 8.52
Clinical flare up (%)	19	17 - 21
Expected production (kg/cow/305-d lactation)	9,080	6,810 - 11,350
Milk price ($/kg)	0.35	0.2 - 0.55
Feed cost ($/kg milk)	0.1847	0.14 - 0.26
Slaughter price ($/kg BW)	1.10	0.88 - 1.32
Cow BW (kg)	680	
Heifer replacement cost ($)	2,000	1,000 - 2,500
New born value ($)	275	200 - 400

RESULTS AND DISCUSSION

For modeling purposes, the full cost of mastitis was estimated to be $480 for primiparous and $533 for multiparous cows as it indicated in Table 2.

Table 2. Estimated cost of mastitis ($/305 d lactation) under baseline conditions defined in Table 1

Cow Group	Milk Losses	Milk Quality Losses	Cost of Premature Culling	Cost of Flare Ups	Cost of Mastitis Transmission	Total Cost of Mastitis
Primiparous	150	216	55	17	41	480
Multiparous	226	216	28	17	46	533

RESULTS AND DISCUSSION

The overall optimal pathway for baseline herd characteristics (Table 1) for primiparous cows suggested: (1) perform a test, (2) use CMT-3 (strong positive) test, (3a) administer antibiotics when the test result is positive, and (3b) take no action when the test result is negative. However, the optimal policy for multiparous cows suggested to do not perform a test and consequently do not provide any treatment.

The value of the right decision can be assessed as the difference of the optimal policy suggestion less alternative actions, Table 3.

Table 3. The value of the right decision ($/cow/305 d lactation)

Parity	Don't test vs. test, or test vs. don't test	Use CMT-1 vs. CMT-3	Use CMT-2 vs. CMT-3	Segregate a positive cow vs. antibiotics	Cull a positive cow vs. antibiotics	Don't treat a positive cow vs. antibiotics
Primiparous	-2.16	-2.96	-1.09	-77.5	-904.52	-48.92
Multiparous	-0.16	-0.64	-0.64	-39.18	-344.97	-10.60

Sensitivity to Biological and Economic Parameters

Herd mastitis prevalence was the most important biological factor and milk price the most important economic factor (Fig. 2 & 3). It is important to note that the changes depicted in Fig. 2 & 3 involve different decisions and consequently the economic outcomes might be non-linear.

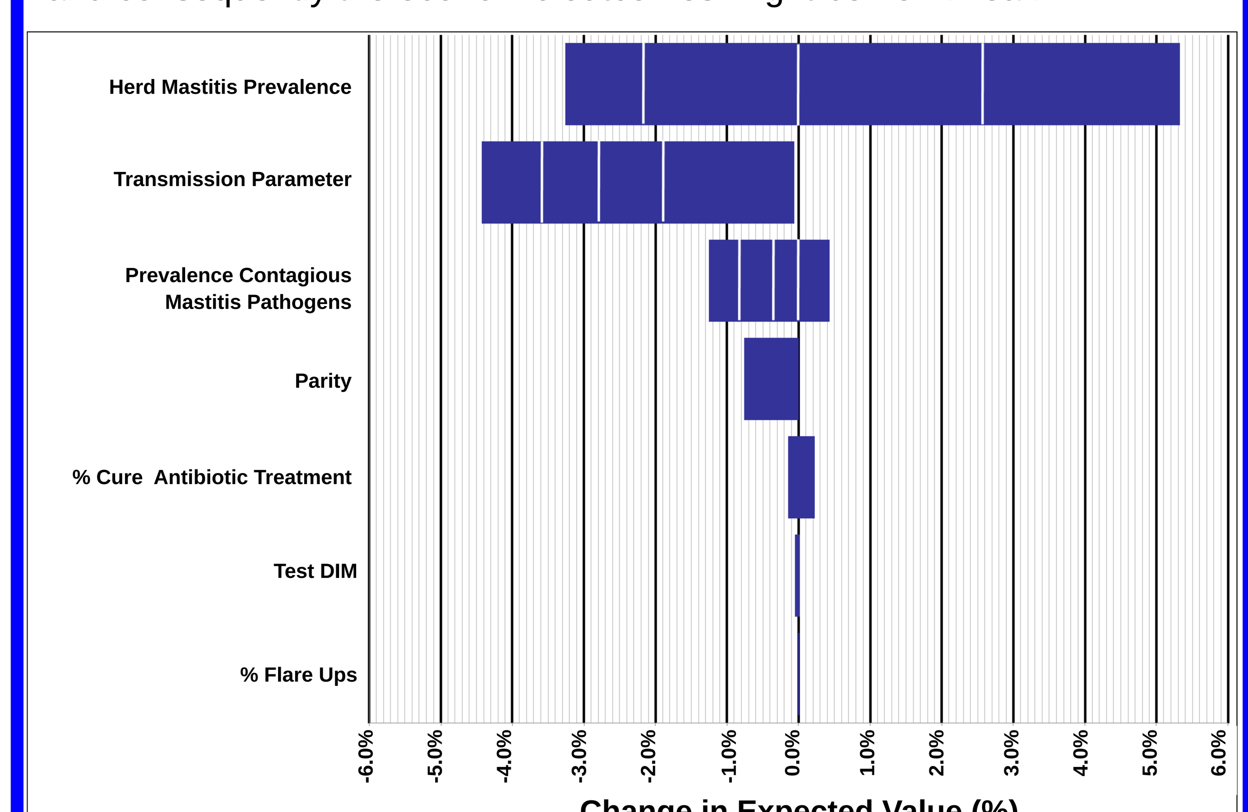

Figure 2. Sensitivity analyses of main biological factors affecting test and treatment decisions between the ranges provided in Table 1

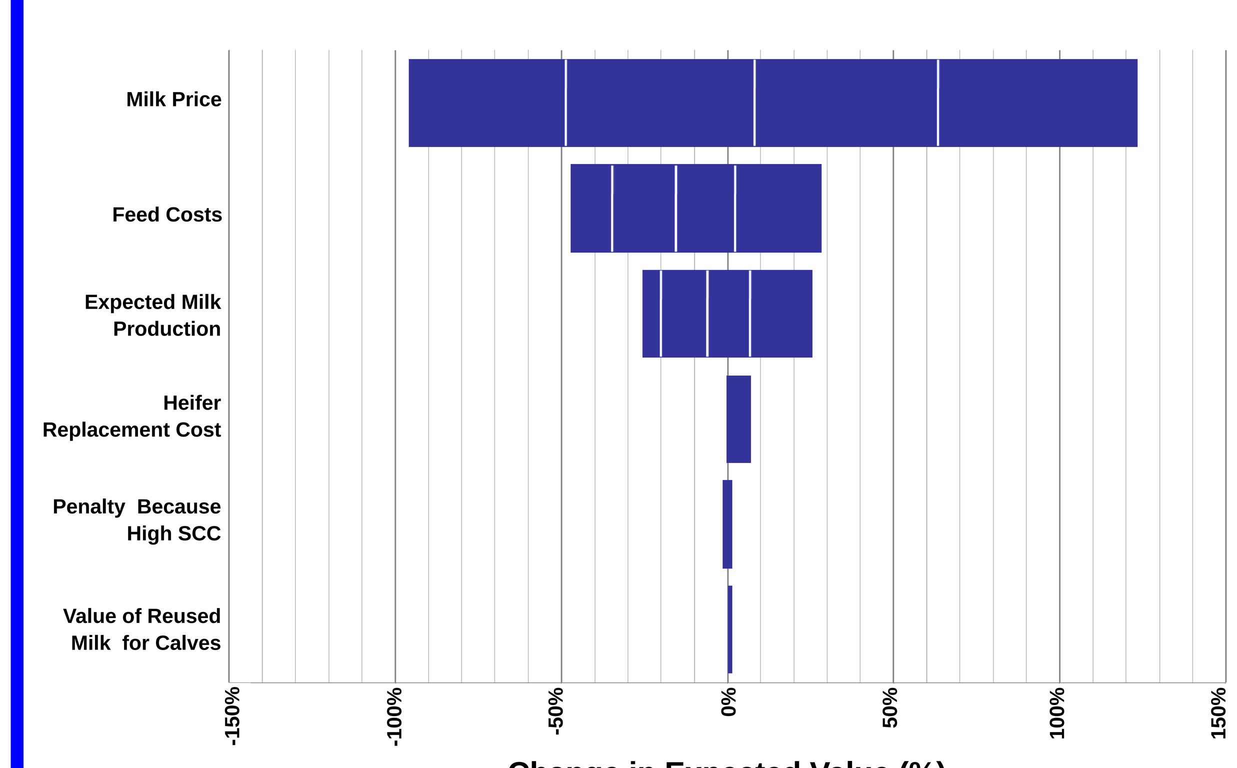

Figure 3. Sensitivity analyses of main economic factors affecting test and treatment decisions between the ranges provided in Table 1

RESULTS AND DISCUSSION

Factors Affecting the Decision of Testing and Treating

The model suggests to perform a test when the herd mastitis prevalence is above certain threshold that varies between 13 and 42% depending on many factors. Besides overall herd mastitis prevalence, the most influential factors were the prevalence of contagious mastitis pathogens, the estimated level of spontaneous cure and the DIM in which the test would be performed as depicted in Fig. 4. Overall, testing is a better option for primiparous cows. The option of testing becomes enhanced when the proportion of the prevalence of contagious mastitis pathogens increases (Fig. 4 A and B), when the spontaneous cure decreases (Fig. 4 C and D), and when the test DIM is day 2 or 3 (Fig. 4 E and F).

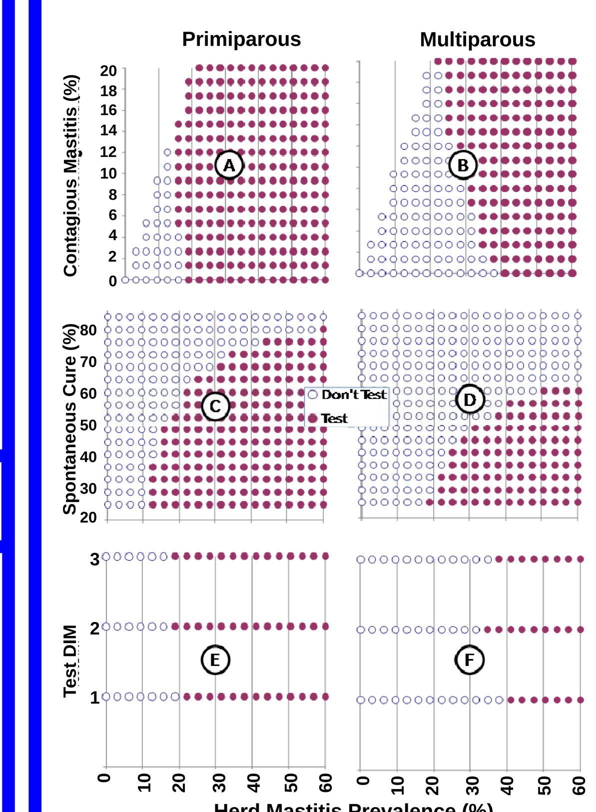

Figure 4. Most important factors affecting the decision of testing for subclinical mastitis

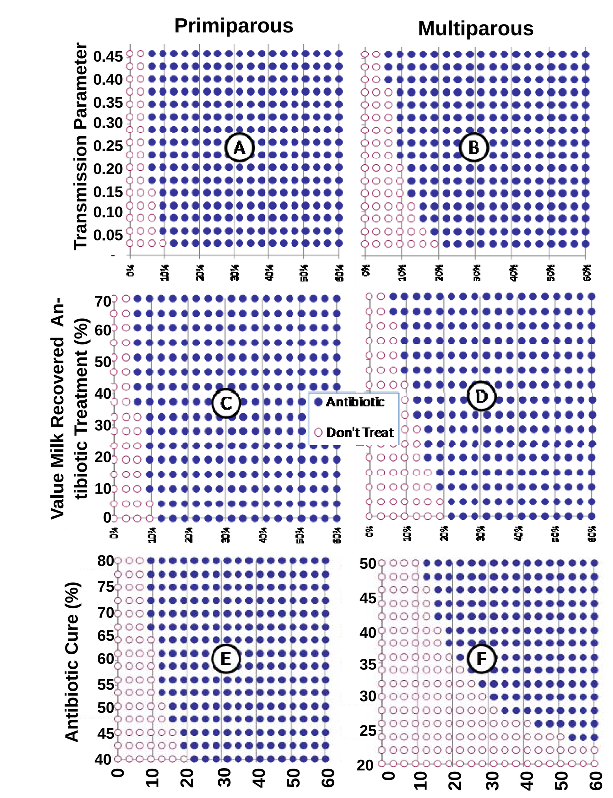

Figure 5. Most important factors affecting the decision of treating for subclinical mastitis

The model suggests to consider antibiotic as an option for positive-tested cows for certain combinations of prevalence and other important factors. The option of using antibiotics is enhanced when the transmission parameter (Fig. 5 A and B), the value of milk recovered after antibiotic treatment (Fig. 5 C and D) and the expected percentage of cure with antibiotic (Fig. E and F) increase.

CONCLUSIONS

Increased opportunity of testing and consequently treating positively-tested cows exist for primiparous cows. Seems that the CMT-3 (strong positive) would be the preferred test because it yields less false positive results. When treatment is selected, the administration of antibiotics could have a benefit to the costs incurred with potential mastitis infections.

The most important factors for early postpartum subclinical mastitis decisions are the herd mastitis prevalence (biological) and the milk price (economic). The opportunity of testing and treating increases when these parameters increase in value.

Other important factors affecting the decision of testing are: the DIM, the spontaneous cure and the prevalence of contagious mastitis; and the decision of treating are: the contagious transmission parameter, the expected cure with antibiotic treatment and the value of the milk recovered after antibiotic treatment.

REFERENCES

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