Economics of Postpartum Uterine Health

Michael Overton DVM, MPVM
University of Georgia, College of Veterinary Medicine
425 River Road
Athens, GA 30602-2771
moverton@uga.edu

John Fetrow VMD, MBA
University of Minnesota, College of Veterinary Medicine

Note: This paper was previously published in the Proceedings of the 2008 Dairy Cattle Reproduction Council Convention, November 7-8, 2008, Omaha, Nebraska and is being reprinted in this conference’s proceedings by permission of the DCRC.

Introduction

The transition period has been identified as a critical time in a dairy cow’s life due to the major physiological changes that are occurring then (Goff and Horst 1997, Drackley 1999). Special management attention should be devoted to improving the feeding, housing and care of animals during this periparturient period due to its impact on early lactation milk production, risk of postparturient disease and overall herd profitability. Postparturient diseases and metabolic issues such as hypocalcemia, ketosis, retained placenta, metritis and abomasal displacement are often directly linked to preparturient management. These and other diseases that occur during the early postparturient period are detrimental because they decrease milk production, increase treatment costs, and increase mortality and culling risk. Indirectly, these diseases affect profitability by increasing the risk of other disease problems. In addition, these problems negatively impact fertility both directly by damaging the reproductive tract and oocytes and indirectly by impacting energy balance and by interfering with the normal hypothalamic-pituitary-ovarian hormonal control system.

Metritis and endometritis, unfortunately, is a very common disease complex observed in postparturient cattle, with a median lactational incidence risk of approximately 10%, but with many herds in the 20 – 30% range (Kelton et al. 1998). Numerous studies have demonstrated both direct and indirect negative impacts of uterine disease on overall dairy herd performance and profitability (Borsberry and Dobson 1989, Lee et al. 1989, Rajala and Grohn 1998, Fourichon et al. 1999, LeBlanc et al. 2002, Gilbert et al. 2005). California researchers found that cows with metritis averaged 4.9 lbs/ day less milk over the first 120 days of lactation compared to normal herdmates (Deluyker et al. 1991). Others have found lower levels of milk loss. Rajala and Grohn reported a loss of 6 lbs/ day for cows with metritis, but only for a period of about two weeks (Rajala and Grohn 1998). Still, others have reported no effect of metritis on milk yield (Bartlett et al. 1986).

Reproductive performance is also negatively affected by metritis that occurs within the first three weeks in milk. Most commonly, the depression in fertility is reported as a change in average days open (typically about 18) or in median days open (range of 13 – 28)(Bartlett et al. 1986, Lee et al. 1989, Fourichon et al. 2000). Perhaps a more appropriate way to examine the fertility impact is to examine the effect on the daily probability of conception for the herd through the use of survival analysis (time-to-event analysis). This is the foundation of the concept of 21-day pregnancy rate. Using this approach, two of the previously cited references determined that metritis lowered the 21-day pregnancy rate by 16 – 30%. In other words, if the normal cows had a 21-day pregnancy rate of 20%, the cows with metritis would have a pregnancy rate of 14 - 16.8%, an absolute reduction of about 3 – 6 units of pregnancy rate performance.

Surprisingly, there is very little peer-reviewed information available that fully evaluates both the direct and the indirect costs of metritis. A complete cost estimate would ideally include the estimated financial losses from decreased milk production, depression in pregnancy rate, increased attributable culling risk, and any treatment costs. The report by Bartlett, et al attempted
to look at both direct and indirect costs associated with metritis and found the total cost per lactation with metritis was $106 in 1986 (Bartlett et al. 1986). The goal of this paper is to estimate the total cost of metritis based on information from a large dairy herd using previously collected production, reproduction and culling data.

Economic Model and Background

A spreadsheet model was built to estimate the total expected cost due to acute puerperal metritis. The data used to estimate milk loss, culling risk, and reproductive performance changes attributable to metritis was adapted from work by M. W. Overton and W. M. Sischo in a single, large dairy herd in California and included 500 cows diagnosed with metritis within the first 10 DIM. Metritis was defined as the presence of an atonic uterus, a malodorous, watery vaginal or uterine discharge, and a fever of 39.4°C (103°F) or greater within the first 10 DIM. Cows experiencing metritis were compared to a randomly selected group of normal cows (not diagnosed with metritis) that were also monitored daily for the first 10 DIM. The overall lactational incidence risk for metritis was 22%. The normal group was a randomly selected group of cows that had been monitored but were not diagnosed with metritis. Milk production information was collected using daily milk meters. Culling and reproductive information was obtained from the on-farm record system (DairyComp 305).

Cows experiencing metritis in the first 10 DIM had a different culling risk (proportion of animals that calved that were later sold or died on-farm) than normal cows. Instead of modeling the cost of culling for each group and then examining the difference, we utilized the attributable risk, calculated by subtracting the risk of culling for the normal cows from the risk of culling for the cows with metritis. The attributable risk for being sold and for dying within the first 60 DIM was calculated by parity group.

Many models will assign a "cost" of the cull by subtracting the salvage value from replacement cost. This is the cash cost of the cull but does not account for varying levels of depreciation that occur as cows go through successive lactations. Using this incorrect approach, a first lactation animal that falls and breaks her leg at one DIM would "cost" the same as a sixth lactation animal that died at one DIM due to severe hypocalcemia. In order to more accurately assess the cost of the cull, one has to determine the expected value of that animal at that given time. The model calculates the cow’s current, depreciated value at the start of her current lactation. Subtracting the salvage value, if any, from this calculated value is a better estimate of the real cost of her removal from the herd.

Within the model, parity-specific attributable culling risks for the first 60 DIM are used to calculate culling losses due to metritis as shown in Figure 1. The salvage value for first lactation animals is $460 and for lactation two and above, it is $621, based on differences in body weight at the time of culling. Culling losses are stratified into losses due to animals that were sold and animals that died. Patterns of culling are very similar between metritis and normal cows from 60 DIM until the end of the breeding period. Culling differences within the breeding period are accounted for within the reproduction model. In this herd, given the assumptions used, the estimated cost of culling within the first 60 DIM is $85 per case of metritis.

Figure 1. Cost of Premature Culling (Sold and Died) From Herd Due to Metritis

<table>
<thead>
<tr>
<th>Lactation</th>
<th>Avg Value at Start of Lactation</th>
<th>Percentage of Total Metritis Cases</th>
<th>Proportion of Total Metritis</th>
<th>Attributable Culling Risk (Sold)</th>
<th>Culling Loss Due to Metritis (Sold)</th>
<th>Weighted Cost of Culls (Sold) Due to Metritis</th>
<th>Attributable Culling Risk (Dead)</th>
<th>Dead Cow Losses Due to Metritis (Dead)</th>
<th>Weighted Cost of Culls (Dead) Due to Metritis</th>
<th>Total Loss to Excess Culling and Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>lact 1</td>
<td>$2,262</td>
<td>33%</td>
<td>4.2%</td>
<td>$1,802</td>
<td>$25</td>
<td>0.5% $2,262</td>
<td>25</td>
<td>0.5% $1,802</td>
<td>0.5% $2,262</td>
<td>$4</td>
</tr>
<tr>
<td>lact 2</td>
<td>$1,863</td>
<td>34%</td>
<td>1.1%</td>
<td>$1,242</td>
<td>5</td>
<td>6.5% $1,863</td>
<td>5</td>
<td>6.5% $1,242</td>
<td>6.5% $1,863</td>
<td>$41</td>
</tr>
<tr>
<td>lact 3</td>
<td>$1,551</td>
<td>18%</td>
<td>2.6%</td>
<td>$930</td>
<td>4</td>
<td>0.3% $1,551</td>
<td>4</td>
<td>0.3% $930</td>
<td>0.3% $1,551</td>
<td>$1</td>
</tr>
<tr>
<td>lact 4</td>
<td>$1,304</td>
<td>16%</td>
<td>5.0%</td>
<td>$683</td>
<td>6</td>
<td>0.1% $1,304</td>
<td>6</td>
<td>0.1% $683</td>
<td>0.1% $1,304</td>
<td>$0</td>
</tr>
</tbody>
</table>

100% | $39 | $46 | $85 | 25
Milk production differences from the data set were incorporated into the model as follows: a) data from the herd showed that cows with metritis that were culled during the first 30 DIM produced 15.1 lbs less milk per day and had a median days-to-exit of 10, b) cows with metritis that were culled during 31 - 60 DIM produced an average of 9.1 lbs less milk per day and had a median days-to-exit of 42, and c) cows with metritis that survived past 60 DIM experienced an average of 6.2 lb loss per day over the first 110 DIM and then no difference over the rest of lactation as compared to the normal cows. A marginal milk value of $0.13 per lb was used, assuming a baseline milk price of $18/ cwt and an expected 2.5 lbs of marginal milk produced per pound of marginal feed consumed. As a consequence, the total estimated milk loss (weighted average) attributable to metritis was $83/ case of metritis as shown in Figure 2.

Figure 2. Cost Associated with Reduced Milk Production Due to Metritis

<table>
<thead>
<tr>
<th>Production Losses (Reduced Milk Production)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Marginal value of lost milk/ metritis case culled (1st 30 DIM)</td>
<td>$ (20)</td>
</tr>
<tr>
<td>% of metritis cases culled/ dead 1st 30 DIM</td>
<td>6%</td>
</tr>
<tr>
<td>Marginal value of lost milk/ metritis case culled (31 - 60 DIM)</td>
<td>$ (49)</td>
</tr>
<tr>
<td>% of metritis cases culled/ dead 2nd 30 DIM</td>
<td>4%</td>
</tr>
<tr>
<td>Marginal value of lost milk/ cow with metritis retained past 60 DIM</td>
<td>$ (89)</td>
</tr>
<tr>
<td>% of metritis cases retained past 60 DIM</td>
<td>90%</td>
</tr>
<tr>
<td>Total milk loss/ case (weighted avg)</td>
<td>$ (83)</td>
</tr>
</tbody>
</table>

The metritis-related cost associated with reduced reproductive performance was estimated using a modified version of Overton’s previously described economic model (Overton 2001, Overton and Galvao 2004, Overton 2006a, Overton 2006b). The reproductive performance data was fit in the model in order to generate a simulated Kaplan-Meier survival plot that approximated the original study data and to estimate the 21-day pregnancy rate for each subgroup by modifying the insemination and conception risk for each 21-day period. Animals that failed to conceive within 12-21day breeding cycles were assumed culled as non-pregnant cows. In addition, variable culling risks were applied within each 21-day period to mimic the dairy’s real results.

A total of 73% of normal cows that calved became pregnant and survived for the entire lactation compared to only 59% for the cows with metritis. The modeled survival plot reveals an attributable culling risk of 8% due to metritis-associated infertility. Combining this 8% risk with the attributable culling risk during the first 60 DIM (5.3%) yields a total that approximates the 14% from the actual data (73% – 59%). Average and median days open were 16 and 33 days longer, respectively, for the metritis group. The predicted 21-d pregnancy rate was 17.5% for the normal cows and 13% for the cows experiencing metritis. As a consequence of the combined effects of excess culling and the costs of extra insemination and breeding program efforts, the predicted monetary loss was approximately $121 per cow in the breeding pool, or $109 per case of metritis, once the total was adjusted to account for the earlier culls. These values were calculated using a replacement cost of $2,200, herd level 305ME of 25,000, a milk price of $18, salvage value of $621, and an interest rate of 8% as inputs in the reproduction model.
The final area of consideration is the direct treatment cost associated with metritis. The model considers two different antibiotic choices for systemic therapy, ceftiofur (Excenel®RTU, Pfizer) and ampicillin (Polyflex®, Fort Dodge), and assumes no therapeutic advantage for one vs. the other. We assumed that one would use the Excenel as per label (1 mg/ lb (2 ml/ 100 lbs) IM or SQ once daily for 5 days) and that Polyflex would also be used once daily for 5 days (5 mg/ lb or 2 ml/ 100 lbs of rehydrated product). The cost per 100 ml bottle was assumed to be $58 for Excenel and $29 for Polyflex based on current market prices for each. Excenel does not require a milk withdrawal and as long as no other therapy that requires a withdrawal is used, the treated cow does not have to enter the hospital pen. Polyflex, on the other hand, has a withdrawal of 48 hours following the last treatment. The model does not consider any supportive therapy or escape therapeutic options since these are assumed to be the same for each drug.

The model allows the user to toggle between the drugs and to also select how the discarded milk is handled if Polyflex is used. If Excenel is used, the estimated cost is $81. If Polyflex is used and the milk is fed as waste milk, the cost is $53 after accounting for the opportunity cost of the discarded milk that is utilized as calf feed. On the other hand, if Polyflex is used and the milk is discarded, the cost is $109, accounting for the lost opportunity cost of the discarded milk.

By adding each of the components of the model together, the total estimated cost of a case of metritis may be determined. The total cost due to culling in the first 60 DIM as a consequence of metritis is $85 per case, the total milk loss due to metritis is $83 per case and the losses due to reproductive issues is $109 per case. The actual treatment cost varies from $53 to $109 depending upon drug used and the utilization of any withheld milk. Using the aforementioned definition of metritis and actual data derived from the farm, the total estimate cost
per case of metritis is $358 if Excenel is used, $329 if Polyflex is used and the milk is used to feed calves, or $386 if Polyflex is used but the withheld milk is discarded.

**Discussion and Conclusion**

The total estimated cost of metritis in this model is significantly higher than the previous estimate cited ($106 by Bartlett et al, 1986). However, a few major differences in herd performance and approach used in the models should be recognized between the two estimates. In the Bartlett paper, which relied on monthly DHIA data, no impact on milk production due to metritis was found. In the current paper, significant losses were identified that were very similar to those reported by Deluyker et al, 1991. Both of these studies used daily milk weights and perhaps there was a greater ability to measure differences with more frequent (and presumably more sensitive) measurements. Other possibilities to explain the discrepancies include a differing level of milk production for the herds investigated and potentially, a difference in the definition for metritis used between the studies. If disease misclassification occurs, the tendency would be to bias the results toward finding no difference due to the inclusion of normal cows in the abnormal group and vice versa.

Bartlett et al reported a very low culling risk overall and an attributable culling risk due to metritis of only 6.1%. In this paper, the attributable culling risk was 5.3% within the first 60 DIM alone, and when combined with the breeding period, the total attributable culling risk was 14%. The difference in attributable culling risk alone accounts for approximately $100 of the large difference between estimates.

Reproductive losses were handled in different ways as well. In Bartlett et al, the total cost due to reproductive failure was estimated to be only $18.89, based primarily on the value of differences in days open. In the current study, the approach used to estimate the reproductive losses used an existing reproductive model to account for changes in expected milk production as a consequence of change in reproductive performance, a difference in number of inseminations, and differences in culling due primarily to reproductive failure. Using commonly cited values for the cost of a day open, the current data set would have a reproductive cost of approximately $48 if only average days open was the criteria used, but this approach underestimates the true cost of the reduced reproductive performance.

It is difficult to address the differences in treatment costs between the two studies. Exact treatment used was not reported by Bartlett et al but they did state that the medication cost per treated cow was only $2.74 as compared to at least $53 in the current study. Milk that was withheld as a consequence of treatment was estimated to cost the dairy $23.85 based on their estimate that approximately half of the milk that was assumed to have been withheld was fed to calves. The price of milk and level of production is likely very different between the two datasets.

In summary, the total cost of metritis in this large herd was estimated to be approximately $358 per diagnosed case, despite aggressive systemic antibiotic therapy. The magnitude of this estimate may surprise some, but the reality is that metritis is an expensive disease problem. If the results of this model are applied to a herd of 1,000 milking cows, and the lactational incidence for metritis is 22% as found with this modeled herd, the total cost would be approximately $79,000 per year using the previously mentioned assumptions. Of course, individual herd costs are likely to vary depending upon treatments utilized, definition of metritis and detection methods used, cow comfort potential, season, nutritional support, etc. Regardless of the exact cost, the authors of this paper suggest that there may be significant financial returns to made by improving transition management in an effort to reduce the risk of developing metritis.