

# Economic Evaluation of Antibiotic Therapy During the Treatment of Acute Coliform Mastitis

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## Introduction

Mastitis is the most costly disease of dairy cattle. Traditionally, most of the cost of mastitis has been attributed to production losses from subclinical cases. Because of this, economic evaluations of the cost of mastitis have focused mainly on contagious mastitis.<sup>1</sup> The relative importance of acute coliform mastitis has recently increased. Acute coliform mastitis appears to be the major mastitis loss on many well managed dairies with a low incidence of contagious mastitis.

The major impact of acute clinical coliform mastitis is production loss from udder and multiple organ system damage and deaths. Because of the sudden onset of severe clinical signs, most cases are generally treated aggressively and with great expense. Although a variety of drugs are used in the therapy of acute coliform mastitis, the economic impact and the efficacy of these treatments has received little research attention.

The purpose of this investigation was to examine the economic impact of treating clinical cases of acute coliform mastitis with gentamicin or sodium ceftiofur and to examine the degree of therapeutic efficacy required for acute coliform mastitis to be treated economically.

## Methods

The profitability of treating dairy cows for acute coliform mastitis was analyzed by use of a partial budget technique. The partial budget was incorporated into a spreadsheet<sup>2</sup> so that data from individual dairy herds could be easily input for evaluation. In this study, data were used so as to represent an average US dairy. The spreadsheet design permits the user to input individual dairy values, before specific recommendations for that dairy are made.

### Spreadsheet layout

**I. Herd inputs** - Average US costs used in this partial budget were taken from 1987 and 1988 USDA averages for the United States when possible. Recent local sources of data were used when average US data were not available.<sup>3,4</sup> Herd size was set at 100 cows for convenience, as the model is independent of herd size. Data for average cull weight and labor costs are estimates.

**II. Farm incidence of clinical coliform mastitis** - The incidence of clinical coliform mastitis may be input directly as the number of cases of acute coliform mastitis that occur in the herd each year. If this data is not available, the total number of acute mastitis cases in the herd per year may be entered and this number will be adjusted by the number of clinical cases expected to be from coliform mastitis. The data for the average number of clinical cases of acute mastitis per lactation were derived as the average of five studies (0.5 cases/lactation).<sup>5,6,7,8,9</sup> The number of cases of coliform mastitis/clinical case of acute mastitis was derived as the average of six studies (0.4 cases of coliform mastitis/case of acute clinical mastitis).<sup>6,7,8,9,10,11</sup>

**III. Various clinical manifestations of coliform mastitis** - The percentage of types of clinical coliform mastitis (uncomplicated, dry quarters, agalactia, and death) were calculated from figures derived from four reports.<sup>6,10,12,13</sup> Milk production losses/lactation were based upon two studies.<sup>14,15</sup> Two

possibilities for culling, either at the time of clinical coliform mastitis or at the next calving, were included in the spreadsheet to reflect the culling policy on the farm being evaluated.

**IV. Cost and efficacy of drug being evaluated** - Cost of drug evaluated includes drug cost, all costs necessary to deliver the drug, and all doses needed to produce the expected reduction in severity of disease. Expected reduction in severity of disease is an approximation of the impact that using this drug will have on the clinical outcome of acute coliform mastitis. It is assumed that percent cases resulting in deaths, percent cases resulting in agalactia, percent cases resulting in a permanent dry quarter, percent cases resulting in temporary dry quarters, and the percent of production lost in cases that return to milk production will decrease at a similar rate. As an alternative, if more specific information is available for the effect of a therapy on production losses, this information may be entered directly into section V.

**V. Clinical manifestation of clinical coliform mastitis after treatment** - This section is similar to section III and outlines expected production losses attributed to acute coliform mastitis if the therapy being evaluated is implemented.

**VI. Disease costs attributable to acute coliform mastitis** - Costs attributable to acute clinical coliform mastitis, with and without treatment, are summarized as calculated from the spreadsheet inputs. The disease costs detailed in the spreadsheet include drug costs of treating cows (drug costs in addition to the drug or treatment that is specifically being evaluated), the cost of discarding milk because of drug residues, labor costs incurred while treating cows, veterinary treatment costs, losses attributable to premature culling, losses attributable to deaths, and the cost of feeding non-productive cows that are culled. Total clinical coliform mastitis herd loss is the total loss expected for the herd with and without implementing the new treatment. Clinical coliform mastitis loss/cow/lactation is the expected loss with and without implementing the new treatment on a per cow lactation basis. Clinical coliform mastitis loss/case clinical coliform mastitis is the loss expected with and without implementing the new treatment for each case of acute coliform mastitis that occurs.

**VII. Profit analysis** - Total profit from treatment is the expected total profit after each cow in the milking herd has completed one lactation. Profit per case of mastitis is the expected profit from implementing the new treatment for each case of acute coliform mastitis. Breakeven drug cost is the treatment cost at which the new treatment generates zero profit. Return on investment was calculated by dividing total profits expected as a result of implementing the new treatment for acute coliform mastitis by the total cost of administering the treatment.

#### Profit analysis

If a particular drug is to be evaluated with the partial budget, individual herd inputs may be entered. In this study, generalized herd data representing an average US dairy were used to evaluate gentamicin and sodium ceftiofur therapy. Gentamicin and sodium ceftiofur therapy of acute clinical coliform mastitis were evaluated. Erskine has suggested that slaughter withdrawals of 14 to 19 months may be needed to eliminate 99.9% of renal gentamicin in dairy cows.<sup>16,17</sup> For this study, six months slaughter and 7 days milk withhold were used with gentamicin and 0 days milk and meat withhold were used with sodium ceftiofur. The author is not presenting these periods as withholding recommendations as residues, particularly gentamicin tissue residues, may result. The effect of drug efficacy, drug cost, and milk production on profits were investigated.

### **Results**

Figure 1 demonstrates that production and death losses will need to be reduced by 28% with gentamicin therapy and 4.4% for sodium ceftiofur, to breakeven financially when used in the therapy of acute coliform mastitis with the described data set.

Gentamicin treatment will cost \$61 more than sodium ceftiofur, per case of acute coliform mastitis, not including any drug cost differential between gentamicin and sodium ceftiofur, during the therapy of

acute coliform mastitis with the described data set.

Figure 2 indicates that gentamicin therapy is increasingly more costly as milk production level goes up. With the described data set, the additional cost of gentamicin treatment over the cost of sodium ceftiofur treatment may be described with the following equation: (cost of gentamicin treatment - cost of sodium ceftiofur treatment) + \$23.40 + 0.858 \* (milk production in pounds/cow/day).

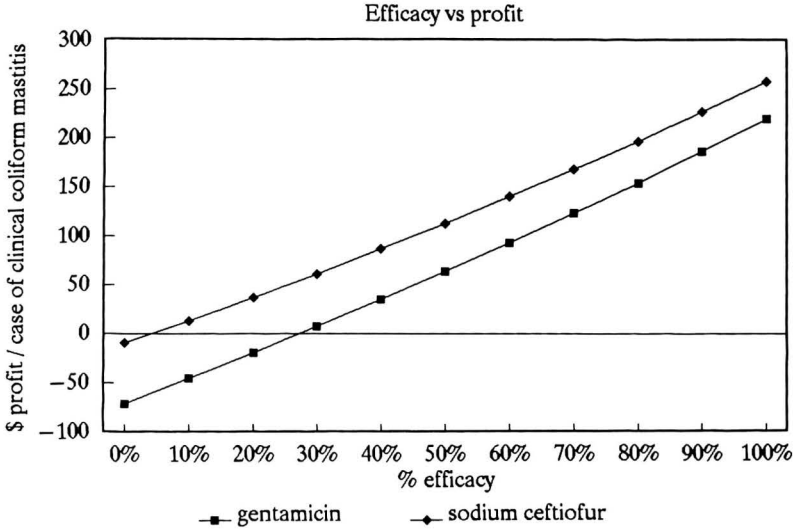


Figure 1

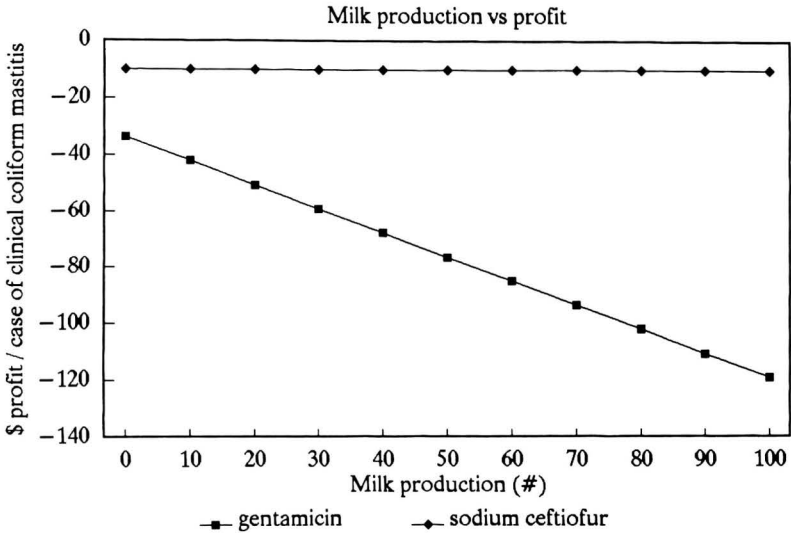


Figure 2

## Discussion

Even without adequate drug efficacy data, profiles of drug therapies may be defined and serve to guide future therapy research. It is apparent that drug efficacies will need to be established if therapies are to be utilized in a profitable and responsible fashion. This study emphasizes the need to investigate therapies that minimize production loss and milk/slaughter withholding requirements.

The cost of a drug administered is only a small part of its actual cost. This spreadsheet makes it possible to model the actual cost of acute coliform mastitis therapy. There have been few controlled studies to investigate milk production losses following acute coliform mastitis with and without therapy. The dairy industry needs this type of information to make sound financial decisions and to reduce potential drug residues.

It is apparent from this study that some of the commonly used drug therapies (i.e. gentamicin) are unlikely to be profitable in the treatment of acute coliform mastitis. Clinical and experimental trials have not demonstrated gentamicin to be efficacious in the treatment of acute coliform mastitis.<sup>13,16,17</sup> While these studies are not conclusive, they do indicate that the 28% reduction in production loss required for gentamicin therapy to be profitable is not likely to be achieved. Also, with an extremely high bacterial self cure rate for acute coliform mastitis, the total impact of antibacterial therapy may be minimal.<sup>18</sup> This also would encourage the development of therapies to minimize the endotoxic components of acute coliform mastitis. An important point of this study is that many of the drugs that are likely to lead to residue violations are also the least economical to use in the treatment of acute coliform mastitis. Some of these therapies simply cannot achieve an efficacy sufficient to cover the cost of increased milk and slaughter withholding. This study underlines the economic importance of investigating therapies with minimal milk and slaughter withhold. Traditional therapies such as quarter stripping and fluid administration, and therapies without withholding requirements will be difficult to surpass economically. Therapies requiring withholding need to be efficacious in direct proportion to drug cost and withholding requirements. This study indicates that future therapies should reduce milk production losses as milk production losses are the most important economic impact of acute clinical coliform mastitis.

Because of the generic nature of the inputs used in this study, the data presented should be viewed as a general guideline. The diverse nature of dairies would suggest that in making appropriate therapy recommendations for a particular dairy, the herd inputs for that dairy should be incorporated into the computer spreadsheet.

## Summaries

The profitability of antibiotic administration, in the therapy of acute coliform mastitis in dairy cows, was analyzed by use of a partial budget technique. The partial budget was incorporated into a computer spreadsheet so that data from individual dairy herds could be easily input for evaluation. In this study, data were used to represent an average USA dairy for the evaluation of gentamicin and sodium ceftiofur therapy.

Production and death loss must be reduced by 28% with gentamicin therapy and 4.4% for sodium ceftiofur, to breakeven financially when used in the therapy of acute coliform mastitis, with the described data set. Gentamicin therapy will cost \$61 more than sodium ceftiofur therapy, per case of acute coliform mastitis, with the described data set and not including any drug cost differential between gentamicin and sodium ceftiofur. Gentamicin therapy becomes increasingly more costly as milk production level goes up. With the described data set, the additional cost of gentamicin treatment over the cost of sodium ceftiofur treatment may be described with the following equation: (cost of gentamicin treatment - cost of ceftiofur treatment) + \$23.40 + 0.858 \* (milk production in pounds/cow/day).

In addition to potential residue problems that may occur with the use of antibiotics and in light of the questionable efficacy of antibiotic therapy during the course of acute coliform mastitis, the economic cost of antibiotic therapy must be considered. It is important to note that antibiotics with long elimination

half-lives and consequently most likely to produce residues, are the least likely to be profitable. Some of the antibiotics in current use, such as gentamicin, are unlikely to achieve efficacies sufficient to cover the cost of increased milk and slaughter withholding. Traditional therapies, such as quarter stripping and fluid administration, and therapies without withholding requirements will be difficult to surpass economically.

La rentabilidad de la administración de antibióticos en la terapia de mastitis coliforme aguda en vacas lecheras fue analizada mediante el uso de una técnica de presupuesto parcial. El presupuesto parcial fue incorporado en una planilla de computación de una manera tal de poder introducir con facilidad datos procedentes de rodeos lecheros individuales. En este estudio, datos generalizados de rodeos lecheros en los Estados Unidos fue usada para evaluar la terapia con gentamicina y ceftiofur sodica.

Perdidas de producción y por muerte deben ser reducidas en un 28% en la terapia con gentamicina y un 4.4% con ceftiofur sodica para cubrir los gastos incurridos en la terapia de mastitis coliforme aguda, de acuerdo a la información generada con los datos entemencionados. En este caso, la terapia con gentamicina costara US \$61.00 por encima de la terapia con ceftiofur sodica, por caso individual de mastitis coliforme aguda, sin incluir diferenciales de costo entre las dos drogas. La terapia con gentamicina se vuelve en creces mas costoso a medida que la producción lechera aumenta. Usando los datos descritos el costo adicional del tratamiento con gentamicina por encima del costo del tratamiento con ceftiofur sodica puede ser descrita con la siguiente formula: (costo del tratamiento con gentamicina - costo del tratamiento con ceftiofur) + US \$23.40 + 0.858 \* (Producción lechera en libras/vaca/dia).

Ademas de problemas potenciales de residuos medicamentosos que pueden ocurrir con el uso de antibióticos y considerando la eficacia cuestionable de la terapia antibiotica durante el curso de mastitis coliforme aguda se debe considerar el costo economico de la terapia antibiotica. Merece notar que los antibióticos que tienen vida media de larga eliminación y consecuentemente sean los que mas probablemente produzcan residuos, son a la vez los que probablemente menos beneficio de costo produzcan. Algunos de los antibióticos de uso corriente, como ser la gentamicina, probablemente no logren alcanzar una eficacia suficiente como para cubrir el costo adicional incurrida por la retención de leche y carne por contener residuos medicamentosos. Terapias tradicionales como ser el orden de cuartos individuales y la fluido-terapia y terapias que no requieran la retención de productos animales destinados a consumición humana seran difíciles de superar economicamente.

Wir analysierten die Profitabilität von Antibiotika Gebrauch in der Therapie von akuter, coliformer Mastitis in Milchkühen mit Hilfe einer Computer Budget Technik. Mit dieser Technik konnten individuelle Daten von Herden leicht ins Programm eingearbeitet werden. Generelle Daten von USA Herden wurden gebraucht um Gentamicin und Sodium Ceftiofur Therapie zu vergleichen.

Produktion und Todesverlust muss mit Gentamicin um 28% und mit Sodium Ceftiofur um 4.4% verringert werden um mit der Behandlung von akuter, coliformer Mastitis die Kosten zu decken. Gentamicin Therapie kostet \$ 61 mehr als Sodium Ceftiofur Therapie ohne den Kostenunterschied der Medikamente in Beachtung zu ziehen. Gentamicin Therapie wird zunehmend teurer als Milchproduktion zunimmt. Die zusätzliche Kost der Gentamicin Behandlung im Vergleich zur Sodium Ceftiofur Behandlung kann mit der beschriebenen Technik so dargestellt werden: Gentamicin Behandlung - Ceftiofur Behandlung + \$ 23.40 + 0.858 \* (Milchproduktion in Pfund/Kuh/Tag).

Die Kosten der Behandlung und der potentielle medikamentöse Rückstand muss beeinträchtigt werden vor allem mit der fragwürdigen Wirksamkeit der antibiotischen Therapie im Verlauf von akuter, coliformer Mastitis. Antibiotika mit langer Halbwertszeit Ausscheidung sind deshalb am wenigsten rentabel. Es ist deshalb unwahrscheinlich dass heutige Antibiotika wie Gentamicin genägende Wirksamkeit erreichen um die Kosten der Höheren Milchproduktion und Schlachtpreise zu decken. Traditionelle Behandlungen wie Viertel Abmelkung und Flüssigkeit Therapie und Behandlungen die keine Wartefrist wegen Antibiotika Verunreinigung verlangen sind ökonomisch schwer zu übertreffen.

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