

The Economics of Bovine Respiratory Disease Treatment Regimens

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Abstract

Bovine respiratory disease (BRD) is the leading cause of feedlot morbidity and mortality in North America, and decisions about BRD therapy are critically important to feedlot veterinarians and their clients. A spreadsheet tool was utilized to evaluate variables having the greatest economic impact on a decision to move from one BRD treatment regimen to another.

Differences in case fatality rate and re-treatment proportion between two potential BRD treatment regimens are important variables when selecting BRD treatment protocols based on return to ownership and management. Other variables unrelated to treatment efficacy that are important for selection of a BRD treatment regimen are sale price and cost of gain. Purchase price of the cattle, morbidity proportion, labor costs not associated with BRD treatment, trucking costs, processing costs, interest rate and yardage cost were not found important to selecting an appropriate BRD treatment regimen.

Résumé

Le complexe respiratoire bovin (CRB) est la principale cause de morbidité et de mortalité des bovins en Amérique du Nord. Le choix d'une thérapie contre le CRB a donc une importance vitale pour les vétérinaires des parcs d'engraissement et leurs clients. Nous avons utilisé une feuille de calcul pour évaluer les variables qui ont le plus d'impact économique sur le changement du régime de traitement contre le CRB. Le taux de mortalité et la nécessité de répéter le traitement s'avèrent des variables importantes dans le choix entre deux régimes de traitement contre le CRB, du point de vue rentabilité et régie pour le propriétaire. D'autres variables, non reliées à l'efficacité du traitement, font également la différence : le prix de vente et le coût du gain. En revanche, le prix d'achat des bovins, le pourcentage de morbidité, le coût de la main-d'œuvre non associé au traitement contre le CRB, les frais de camionnage et de transformation, le taux d'intérêt et les frais de dépôt n'influençaient pas le choix du traitement approprié.

Introduction

Undifferentiated bovine respiratory disease (BRD) is the primary cause of feedlot cattle morbidity and mortality losses in the first 45 days after arrival at a feeding facility.^{6,10} Edwards reported that 65 to 80% of morbidity within a feeding period occurred in the first 45 days, and 67 to 82% of the total morbidity was due to respiratory disease.⁶ Mortality proportions ranged from 0.57 to 1.07% of all cattle received, with respiratory disease accounting for 46 to 67% of deaths.⁶ Vogel and Parrott used data collected from January 1990 to May 1993 and reported that the mean monthly mortality proportion due to respiratory disease for the feedlots where data was collected was 0.128% (1.28 respiratory mortalities per month per 1,000 head on feed), with 44.1% of all mortalities due to respiratory disease.¹⁰

Death of cattle has been reported as the major contributor to economic loss associated with BRD in feedlot cattle.⁸ Other costs of BRD are cost of treatment, decrease in weight gain and carcass value of affected cattle. A few investigators have reported the importance of morbidity and mortality proportions in feedlot cattle on weight gain. In a Canadian study, calves treated for respiratory disease had 0.13 lb (0.06 kg) lower average daily gain (ADG) than those not treated.⁴ Wittum *et al* found that presence of pulmonary lesions at slaughter was associated with a 0.17 lb (0.08 kg) reduction in mean daily gain compared to calves without lesions.¹¹ In contrast, the same study found no difference in mean daily gain between calves showing clinical signs of BRD and treated with antimicrobials and those not treated.¹¹ Another recent study showed that feedlot steers treated for respiratory disease had lower ($P < 0.05$) final live weights, ADG, hot carcass weight, and less external and internal fat.⁷ In addition, Gardner *et al* showed that steers with lung lesions at slaughter had lower daily gains, lighter hot carcass weight, less internal fat, lower marbling scores and greater longissimus shear force values after seven days of aging than from steers without lung lesions ($P < 0.05$). The Gardner study made no attempt to differentiate between cattle treated once for respiratory disease which responded to treatment and those that failed to respond to the initial treatment.

Other authors have reviewed BRD, and the antimicrobial spectrum, physicochemical properties, pharmacokinetics, and legal and ethical considerations for antimicrobial and ancillary therapies of BRD.^{1,2,5,9} Apley reviewed respiratory disease therapeutics including susceptibility profiles for BRD pathogens.³ Once appropriate alternatives are identified based on pharmacologic, legal and ethical considerations, determining the improvement needed in treatment efficacy to move to a more expensive BRD treatment or conversely, determining the decreased treatment efficacy that is acceptable to move to a less expensive treatment, will direct the final treatment decision.

Practitioners must make respiratory disease therapy recommendations for their clients with a measurable economic objective in mind. The computerized spreadsheet model described in this paper can be used to evaluate the economic effects of treatment decisions. Sensitivities of the variables included in the model are examined to determine how variables should be weighted in the decision between alternative treatments. Sensitivity of an output to a particular input is defined as the percentage change in an output of interest when an input is changed a set amount. For this paper, sensitivity was evaluated by changing input values by 10%.

Materials and Methods

For this paper, the following definitions are used:

- **Morbidity proportion:** number of animals pulled for treatment of undifferentiated BRD, divided by number of animals in the received group.
- **Mortality proportion:** number of animals in the received group that died due to BRD, divided by the number of animals in the received group.
- **Case fatality rate (CFR):** number of animals in the received group treated for BRD and subsequently die due to BRD, divided by number of animals treated for BRD.
- **Treatment success:** those animals meeting the case definition for absence of respiratory disease at the end of the time designated for the treatment regimen.
- **Treatment failures:** animals requiring a second treatment for the same BRD occurrence because their clinical appearance markedly deteriorated or did not improve during the time allotted for the treatment regimen, divided by total number of treated calves.
- **Relapse proportion:** number of animals considered treatment successes (i.e. designated as cured after the initial treatment regimen is completed) that are pulled from the pen with BRD (require a second medication) later in the feed-

ing period, divided by total number of initially treated calves.

- **Re-treatment proportion:** the sum of treatment failures and relapses.
- **Chronic proportion:** number of animals that did not respond to three treatments for BRD, divided by total number of calves purchased.

A spreadsheet model compares return to ownership and management between a given current BRD treatment regime and an alternative with a different re-treatment proportion and/or CFR. Income in this model is based on a live-weight marketing system and thus uses pounds of live animal sold; therefore, differences in carcass quality that may exist between cattle with or without BRD are not variables in the model. Variable costs associated with feedlot production of beef cattle are included in the model. Return to ownership and management includes dollars available for fixed costs and return on investment. Given the return to ownership and management when the original BRD treatment is utilized, if CFR and re-treatment proportion are different with an alternate BRD treatment, the pounds sold and cost of gain will be different than for the original situation. By changing pounds sold and cost of gain appropriately, the model calculates dollars available to move to the alternative. The model output, dollars available, indicates the amount one could pay for an alternate treatment in excess of the current treatment cost and still be return equivalent when pounds sold, cost of gain (COG), and treatment cost are different with the alternate treatment. Economic differences between therapy options include differences in treatment cost, treatment response proportion and CFR, as well as differences in gain and efficiency, as measured by COG of treatment groups.

For example purposes, the spreadsheet is used to model two situations, a calf-fed and a yearling model. Using the identified minimum and maximum values for each of the input ranges, all possible combinations of inputs (n=144) for the calf-fed and yearling models are evaluated. The two greatest-dollars-available-for moving to a different BRD treatment regimen resulted from high fed cattle prices, low COG, high original treatment cost, high morbidity, high re-treatment proportion and CFR when using the original BRD treatment, and great improvement in re-treatment proportion and CFR when moving to the alternate BRD treatment.

Using anecdotal inputs compiled from several veterinary feedlot specialists, a number of assumptions not related to animal performance are held constant in the models. In order to measure the confidence one could place in the assumptions, sensitivities were determined. For the calf-fed model, yardage is assumed to be 20 cents per head, per day and processing product cost is \$9.00.

Interest rate is assumed to be 10%. This could be considered the interest paid on borrowed money or opportunity cost of capital invested in alternate ventures. Interest is charged for the entire feeding period for purchase price and processing cost, while interest on feed, yardage, labor, treatment and re-treatment costs is charged for one-half the feeding period. Calves are purchased at 450 lb (205 kg) (pay weight) and fed for 225 days. Non-management labor costs not associated with BRD treatment are assumed to be \$1.00 per head. Mortality due to BRD is distributed so that the mean date of death is on day 30 of the feeding period. The percentage of calves determined to be chronically affected with BRD and sold is assumed to be equivalent to the mortality proportion, and the net return for chronically affected calves is assumed to be \$150 less than the pen average. A \$1 per head marketing fee is assessed at sale, and \$11 for trucking cost is assumed.

The same assumptions are made with the yearlings as with the calves, with the following exceptions: yardage is assumed to be 28 cents per head per day, yearlings are purchased at 700 lb (318 kg) (pay weight) and fed for 141 days, and processing product cost is \$11 per head.

The variables in the spreadsheet model include both those factors potentially affected by BRD treatment and those independent of BRD treatment choice. The factors potentially affected by BRD treatment choice are CFR and re-treatment proportion. In order to determine these variables' effect on COG, CFR is evaluated for its effect on weight sold, and re-treatment proportion is evaluated for its effect on weight sold and treatment cost. The model variables that differ between groups of cattle, feedyards, years, and other measures of time, but are independent of BRD treatment choice, are price paid for cattle, COG, morbidity proportion, price received and decrease in ADG after one treatment and after more than one treatment for BRD.

Results

The assumptions made in the model are tested for robustness using sensitivity analysis of the model variables identified. A 10% change in the value of each assumption results in less than a 0.001% change in dollars available to move to an alternate BRD treatment for hired labor costs independent of BRD treatment costs, trucking costs and processing costs for both the calf-fed and the yearling models. Dollars available for moving to an alternate BRD treatment is more sensitive to the assumptions for interest rate and yardage. But a 10% change in these variables still results in less than a 1.0% change in dollars available to move to an alternate BRD treatment. Of the assumptions in the model, dollars available to move to an alternate BRD treatment is most

sensitive to decreased return for chronic cattle sold. A 10% change in the decreased return for chronically affected BRD cattle sold results in a 1.34 to a 3.26% change in dollars available for the calf-fed model, and 1.73 to 2.95% change in dollars available for the yearling model. With the exception of decreased return for chronics, dollars available for moving to an alternate BRD treatment are not sensitive to the assumptions in the model.

The spreadsheet model is used to calculate dollars available for an alternate BRD treatment regimen when factors potentially affected by BRD treatment, CFR and re-treatment proportion are varied. The sensitivity of these factors on dollars available to move to a different BRD treatment is done to determine the relative importance of each when selecting a BRD treatment. Dollars available to move to an alternate BRD treatment is sensitive to both a change in CFR and a change in re-treatment proportion. Dollars available is slightly more sensitive to a change in re-treatment proportion than CFR.

A 10% decrease in CFR of calf-fed animals results in 0.009% to 0.164% greater pounds sold, which allows an alternate treatment that reduces CFR by 10% to be 1.74 to 11.51% greater in cost and still be return-equivalent. A 10% decrease in re-treatment proportion of calf-feds results in 0.004 to 0.174% greater pounds sold and 0.917 to 4.000% decreased treatment cost compared to a system utilizing the original BRD treatment. This allows an alternate treatment that reduces re-treatment proportion by 10% to be 3.22 to 18.13% greater in cost and still be return-equivalent.

A 10% decrease in CFR of yearlings results in 0 to 0.504% greater weight sold, which allows an alternate treatment that reduces case fatality rate by 10% to be 1.23 to 6.89% greater in cost and still be return-equivalent. A 10% decrease in re-treatment proportion of yearlings results in 0.002 to 0.114% greater weight sold and 0.007 to 2.700% decreased treatment cost compared to a system utilizing the original BRD treatment. This allows an alternate treatment that reduces re-treatment proportion by 10% to be 1.65 to 10.45% greater in cost and still be return-equivalent.

The spreadsheet model is also used to determine the effect of cost and production environments that are independent of BRD treatment efficacy on dollars available to move to an alternate BRD treatment, and to determine if these environments significantly alter BRD treatment decisions. Purchase price, sale price, COG, original treatment cost and morbidity are varied for each production scenario. Sensitivities for the inputs that are varied in the model are calculated to determine the importance of each variable as a predictor of the effect of changing feeding conditions on dollars available for treatment. Dollars available to move to an alternate BRD treatment is sensitive to sale price and COG, and

somewhat sensitive to the original treatment cost for the calf-fed model. Dollars available is sensitive to sale price, and is somewhat sensitive to COG and the original treatment cost for the yearling model. Dollars available for moving to an alternate BRD treatment is not sensitive to purchase price or morbidity proportion.

The model is also used to test the sensitivity of COG for the range of inputs for decreased ADG following one, or more than one treatment for BRD used in the model. Cost of gain is relatively insensitive to the range in decreased ADG following one treatment for BRD (3.5 to 10%) used in the model. And, COG is relatively insensitive to the range in decreased ADG following more than one treatment for BRD (10 to 20%) used in the model. Therefore, even if one disputes the extent of reduction in ADG following treatment for BRD used in the model, the input of interest for this model—cost of gain—is relatively insensitive to changes in this value.

Discussion

Our modeling shows that both CFR and proportion of re-treatment are important BRD treatment variables when determining dollars available to move to an alternate BRD treatment. A decrease in either CFR or re-treatment proportion provides increased dollars available for BRD treatment. Variables not related to BRD treatment efficacy are also important when determining dollars available to move to an alternate BRD treatment. Sale price and COG are important for selecting the BRD treatment in calf-fed management systems. In periods of high sale price or low COG, more dollars are available to move to an alternate treatment regimen that decreases CFR and/or re-treatment proportion than during periods of low sale price or high COG. Cost of the original treatment is less important than sale price or COG for evaluating alternate BRD treatments for calf-fed management. However, the higher the original treatment cost, the greater the dollars available for moving to an alternate treatment regimen. When feeding yearlings, the relative importance of cost of the original BRD treatment increases, and the importance of COG decreases when compared to calf-fed management. Sale price is important, and cost of the original treatment and COG are less important than sale price when selecting the BRD treatment regimen for yearlings. Purchase price and morbidity proportion are not important predictors of dollars available to move to an alternate BRD treatment that decreases CFR or re-treatment proportion for either calf-fed or yearling management systems.

Although COG is important when selecting BRD treatment options, dollars available to move to an al-

ternate BRD treatment are relatively insensitive to non-feed components of COG used in the model. Labor cost, trucking cost, processing product cost, interest rate and yardage are not important for predicting dollars available for an alternate BRD.

Conclusions

The differences in CFR and re-treatment proportion between two potential BRD treatments are important variables when selecting BRD treatment protocols based on return to ownership and management. Other variables unrelated to treatment efficacy that are important for selection of a BRD treatment regimen for calf-fed management systems are sale price and COG. Given constant differences in CFR and re-treatment proportion between two BRD treatments, the dollars available to move to the more effective treatment are greater when sale price is high or COG is low. For yearlings, sale price is important when selecting a BRD treatment, however, original BRD treatment cost is relatively more important and COG is relatively less important when compared to calf-fed management. Purchase price of the cattle, morbidity proportion, labor costs not associated with BRD treatment, trucking costs, processing costs, interest rate and yardage cost are not important when selecting an appropriate BRD treatment.

References

1. Apley MD: Antimicrobial therapy of bovine respiratory disease. *Vet Clin North Am Food Anim Pract* 13:555-574, 1997.
2. Apley MD: Ancillary therapy of bovine respiratory disease. *Vet Clin North Am Food Anim Pract* 13:575-592, 1997.
3. Apley MD: Respiratory disease therapeutics in: Howard JL and Smith RA (eds): *Current Veterinary Therapy 4: Food Animal Practice*. Philadelphia, WB Saunders Co, 1999, pp 462-471.
4. Bateman KG, Martin SW, Shewen PE, Merzies PI: An evaluation of antimicrobial therapy for undifferentiated bovine respiratory disease. *Can Vet J* 31:689-696, 1990.
5. Clarke CR, Burrows GE, Ames TR: Therapy of bovine bacterial pneumonia. *Vet Clin North Am Food Anim Pract* 7:669-694, 1991.
6. Edwards AJ: Respiratory diseases of feedlot cattle in the central USA. *Bov Pract.* 30:5-7, 1996.
7. Gardner BA, Dolezal HG, Bryant LK, Owens FN, Smith RA: Health of finishing steers: Effects on performance, carcass traits, and meat tenderness. *J Anim Sci* 77:3168-3175, 1999.
8. National Agricultural Statistics Service: *Cattle and calves death loss*. Washington, DC, USDA, 1992.
9. Perino LJ, Apley MD: Bovine respiratory disease, in: Howard JL and Smith RA, (eds): *Current Veterinary Therapy 4: Food Animal Practice*. Philadelphia, WB Saunders Co, 1999, pp 446-455.
10. Vogel GL, Parrott JC: Mortality survey in feedyards: the incidence of death from digestive, respiratory and other causes in feedyards in the Great Plains. *Compend Contin Ed Pract Vet* 16:227-234, 1994.
11. Wittum TE, Woollen NE, Perino LJ, Littledike ET: Relationships among treatment for respiratory tract disease, pulmonary lesions evident at slaughter, and rate of weight gain in feedlot cattle. *J Am Vet Med Assn* 209:814-818, 1996.