Economic Considerations with Bovine Respiratory Disease Interventions

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Abstract

A Monte Carlo spreadsheet (Microsoft® Excel; Oracle® Crystal Ball) model was designed to compare return to ownership and management between alternate bovine respiratory disease (BRD) prevention strategies and between alternate first-pull BRD treatment regimens based on probability distributions of performance variables, as well as different BRD risk and outcome (re-treatment percentage and/or case fatality risk). These stochastic models indicate that factors unrelated to the incidence and outcome of BRD are important drivers affecting the economic value of both BRD prevention and treatment. Results also indicate that today's historically high cost of gain places negative pressure on the economic value of BRD prevention and treatment. In addition, the models indicate that level of morbidity risk has a stronger association with dollars available to prevent or treat BRD than any of the measures of BRD prevention or treatment effectiveness. Therefore, being able to accurately predict groups of cattle at high risk for BRD and focusing expenditures on those groups, while minimizing expenditures on cattle with low BRD incidence, has the highest potential for economic payback, and this is increasingly important as cost of gain increases.

Résumé

Un modèle Monte Carlo sur chiffrier (Microsoft® Excel; Oracle® Crystal Ball) a été développé afin de permettre à la direction et aux propriétaires de comparer les retombées de différentes stratégies de prévention des maladies respiratoires bovines et de différents régimes de traitements initiaux de ces maladies, basé sur la distribution de probabilités de variables de performance, de même que les différents risques et résultantes (le taux de retraitement et/ou le risque de fatalité) de ces maladies respiratoires bovines. Ces modèles stochastiques indiquent que des facteurs qui ne sont pas reliés à l'incidence ni à la résultante des maladies respiratoires influencent grandement la valeur économique du traitement et de la prévention des maladies respiratoires. Les résultats montrent aussi que le coût historiquement très élevé des gains aujourd'hui diminue l'attrait économique de la prévention et du traitement des maladies respiratoires. De plus, les modèles nous montrent que le niveau du risque de morbidité est plus fortement associé à l'argent disponible pour prévenir ou traiter les maladies respiratoires qu'à l'efficacité de n'importe quelle mesure de prévention et de traitement de ces maladies. Par conséquent, bien prédire les groupes de bovins à haut risque pour les maladies respiratoires et aussi cibler les dépenses sur ces groupes, tout en minimisant les dépenses pour les bovins à faible risque, offre le plus grand potentiel de retombées économiques, ce qui est d'autant plus important que le coût des gains ne cesse d'augmenter.

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.[7,14] Death of cattle has been reported to be a major contributor to economic loss associated with BRD in feedlot cattle.[11] Other costs of BRD are cost of treatment and decrease in weight gain and carcass value of affected cattle.[5,8,10,13,15] Other authors have reviewed BRD, and the antimicrobial spectrum, physiochemical properties, pharmacokinetics, and legal and ethical considerations for antimicrobial and ancillary therapies of BRD.[1,2,3,6,12] Once appropriate BRD prevention and treatment alternatives are identified based on immunologic, pharmacologic, legal, and ethical considerations, determining the improvement needed in BRD risk or treatment efficacy to offset additional expense will direct the final prevention or therapy decision.

Very little work has been published evaluating the relative importance of production and health variables on the economic value of different BRD treatment or prevention strategies. An earlier model by Larson and Pierce[9] used a deterministic model to evaluate BRD treatment decisions, and they reported that for both calf-fed and yearlings, the differences in case fatality risk and re-treatment percentage between two alternate BRD treatments were important variables when selecting BRD therapeutic plan protocols based on return to ownership and management.[9] Other variables unrelated to treatment efficacy that were important for selection of a BRD treatment regimen for calf-fed management systems were sale price and cost of gain (COG), in that dollars available to move to a more effective treatment were greater when sale price was high or COG was low.

The COG and the cost of feeder and fed cattle have increased appreciably since the 2001 publication by Larson and Pierce. Based on today's economic and production realities, practitioners must make BRD prevention and therapy recommendations for their clients with a measurable economic objective in mind. The stochastic model described in this paper was used to evaluate the economic effects of BRD prevention and treatment decisions. Sensitivities of the model assumptions provide an indication of the influence each variable has on the outcome, allowing one to determine which variables are the most important and least important in the model forecast.

Materials and Methods

A Monte Carlo spreadsheet (Microsoft® Excel[a]; Oracle® Crystal Ball[b]) model was designed to compare return to ownership and management between two competing BRD prevention strategies based on probability distributions of performance variables, as well as differing BRD morbidity risk. Within each model iteration, income was estimated based on a live-weight marketing system utilizing pounds of live animal sold; therefore, differences in carcass quality that may exist between cattle with or without BRD are not included 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.

The model output, additional dollars available for a competing BRD prevention strategy, indicates the dollars that one could pay for additional BRD prevention in excess of the current prevention costs and still be return-equivalent. Economic differences between prevention strategies are driven by differences in morbidity risk and the subsequent losses due to death, reduced average daily weight gain, and treatment costs associated with BRD.

Using inputs compiled from a database of pen-level feedlot data or published literature where possible (anecdotal inputs compiled from several veterinary feedlot specialists were used where data were lacking), the variables in the spreadsheet model include both those factors potentially affected by BRD morbidity risk and those that are independent of BRD prevention strategy. The model variables that differ between groups of cattle, feedyards, years, and other measures of time, but are independent of BRD prevention strategy, are price paid for cattle, COG, price received, and decrease in average daily gain (ADG) after one treatment and after more than one treatment for BRD.

A second Monte Carlo spreadsheet (Microsoft® Excel[a]; Oracle® Crystal Ball[b]) model was used to compare return to ownership and management between two alternate first-pull BRD treatment regimes with different re-treatment percentage and/or case fatality risk. Just as with the spreadsheet evaluating the value of competing BRD prevention strategies, income was estimated based on live weight; therefore, differences in carcass quality are not included in the model. The same variable costs associated with feedlot production of beef cattle are included in the model as with the BRD prevention strategy model.

The model output, additional dollars available for the alternate first-pull BRD treatment regimen, indicates the dollars that one could pay for an alternate treatment in excess of the current treatment cost and still be return-equivalent. Economic differences between therapy options include differences in treatment response percentage and case fatality risk (CFR), as well as differences in pen-level ADG.

The variables in the spreadsheet model include factors potentially affected by BRD treatment (case fatality risk and treatment success) and those that are independent of BRD treatment choice. In order to determine these variables' economic effects, CFR is evaluated for its effect on weight sold, and re-treatment percentage 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 percentage, price received, and decrease in ADG after one treatment and after more than one treatment for BRD.

Results and Discussion

Dollars Available for an Alternate BRD Prevention Strategy

Using the model assumptions, the value for decreasing BRD morbidity risk has a strong right-skewed distribution. This is not surprising because the distribution of pen-level morbidity risk is right-skewed, with the most commonly reported risk being 0%, and 54.8% of pens in one large study reporting less than 5% cumulative morbidity risk during the first 100 days-on-feed.[4] Pens with no or very low morbidity risk are not likely to have a positive economic response to increased BRD prevention expenditures. However, according to this model, there is substantial value for decreasing BRD risk for some pens using the assumed reduction of BRD morbidity risk (improvement ranging from 0% to 60%, with the most common improvement being 30%) for available prevention strategies.

The assumptions made in the model are tested for relative importance in the BRD prevention strategy decision using sensitivity analysis of the model variables. Sensitivity analysis revealed that the level of morbidity risk that would occur without the additional prevention

strategy has a greater impact on dollars available than the improvement in morbidity risk if the prevention strategy is used. The analysis also revealed that as COG increases, the dollar value of decreased BRD morbidity risk due to adoption of prevention strategies decreases. This was somewhat offset by increased fed cattle price increasing the value of decreased BRD morbidity risk. All the other variables in the model (e.g. cost of BRD treatment, CFR, re-pull risk, and ADG of both healthy and BRD-affected cattle) had minimal effect on the dollar value of BRD prevention.

Dollars Available for an Alternate BRD Treatment Regimen

Using the model assumptions, the value for moving to an alternate treatment regimen also has a strong right-skewed distribution, indicating that in many pens of cattle, there are few dollars available to move to an alternate BRD treatment (assuming the distribution of improved re-pull risk and CFR with the alternate treatment varied from 0% to 60%, with the most common being 30% improvement), but there are a few situations with substantial dollars available for an alternate treatment regimen.

Sensitivity analysis based on this model revealed that pens with higher baseline morbidity risk have more dollars available to spend on first-pull BRD treatment. In addition, pens with higher baseline CFR and re-pull risk have more dollars available for BRD treatment. These observations are consistent with the hypothesis that it is reasonable to expend additional resources to aggressively treat cattle identified with BRD that have a higher risk of death or treatment failure. The COG was negatively associated with additional dollars available for first-pull BRD treatment, meaning that as cost of gain increases, the dollars available to consider alternate first-line BRD treatment are reduced. Interestingly, variables associated with improved treatment response (i.e. improvement in CFR and improvement in re-pull risk) were not as important to the value of competing BRD treatment regimens as baseline BRD risk and current treatment response. Variables that impacted the BRD treatment decision minimally included cost of current BRD treatment and ADG for both healthy and BRD-affected cattle.

Limitations of Models

Several of the assumptions in the models, including correlations between variables, are largely undocumented in published literature. In addition, assumptions about morbidity risk, re-pull risk, and CFR in the models combine all classifications of cattle. Whereas, in most BRD prevention or treatment decisions, a preliminary assessment of BRD risk would be made, and if the models had been run specifically for high-risk cattle (or low-risk cattle), I would expect the relative importance of different morbidity risk within risk classifications of cattle to decrease in importance and other variables to increase in importance in decisions about resource allocation for BRD prevention and treatment. If specific feedlot-generated data are available to a veterinarian or feedlot, the model can be used to address questions of optimized prevention and treatment expenditures, but those results may not be widely applicable to other situations.

Conclusion

These stochastic models indicate that both BRD morbidity risk and factors unrelated to the incidence and outcome of BRD are important drivers affecting the economic value of BRD prevention and treatment. Today's historically high COG acts to decrease the dollars available to prevent BRD and to mitigate BRD effects on CFR and re-pull risk. In contrast, historically high fed-cattle prices increase the economic value of BRD prevention and treatment. To visualize the role that increasing COG has on BRD management decisions, one must recognize that if the cost of each pound of gained weight increases, while the value of each pound of weight stays the same, there are fewer dollars available to increase those pounds by decreasing BRD effects. In contrast, if the value of each pound of weight gained increases (i.e. increased fed-cattle price), while the cost of each pound of gained weight stays the same, more dollars are available to increase those pounds by decreasing BRD effects.

Another interesting outcome of this study is recognition that the level of morbidity risk has a stronger association with dollars available to prevent or treat BRD than any of the measures of BRD prevention or treatment effectiveness. In other words, knowing which cattle to implement enhanced BRD prevention or treatment is a more important economic consideration than the selection of the actual intervention. This study indicates that being able to accurately predict groups of cattle at high risk for BRD and focusing expenditures on those groups, while minimizing expenditures on cattle with low BRD incidence, has the highest potential for economic pay-back.

Endnotes

[a]Microsoft® Corporation, Redmond, Washington
[b]Oracle® Crystal Ball, Fusion Edition, Redwood Shores, California

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