Evaluation of predictive models to determine final outcome for feedlot cattle based on information available at first treatment for bovine respiratory disease

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Introduction

Bovine respiratory disease (BRD) is the costliest health condition affecting feedyards in North America. Accurate identification of severe disease has the potential to aid in establishing an intervention to prevent a case fatality in individual animals. The study objective was to evaluate the diagnostic ability of predictive models to determine the probability a calf at first BRD treatment would finish the feeding period with the group or incur a negative outcome (railed or died). Additional comparisons were made to evaluate potential benefits to predictive model performance by the addition of weather data, utilization of a data balancing technique, and creation of models for individual feedlots.

Materials and methods

Individual animal, pen-level, and feedyard-level data available at the time of first BRD treatment were used to train and test predictive models. The final dataset consisted of 96,382 BRD cases from 12 feedlots of which 14.2% of cases did not finish the feeding period (DNF). Data were split into training (75%) and testing (25%) datasets, stratified by outcome of interest (DNF). Five algorithms were trained using the training dataset: advanced perceptron, decision forest, logistic regression, neural network, and boosted decision tree. Manual threshold probability adjustments to maximize F1 score to balance sensitivity and positive predictive value were performed to tune models. Predictive models were evaluated using the testing dataset based on final accuracy, sensitivity (Sn), specificity (Sp), positive and negative predictive values, and area under the receiver operating characteristics curve (AUC).

Results

Overall, predictive power of the models was moderate with a median AUC value of 0.675. The decision tree model offered the highest accuracy (73.6%) with Sn of 57% and Sp of 76.3%. Addition of weather data had little effect on AUC but resulted in more variation in Sn and Sp values. Oversampling the training dataset decreased AUC values numerically but generally had little effect on other performance metrics. Models created for individual feedyards performed better or worse than the baseline models depending on the feedyard. This could indicate some discrepancies in the data quality collected at different feedyards.

Significance

To conclude, the models created using first BRD treatment data predicted DNF with moderate accuracy and had better negative predictive value than positive predictive value. The addition of weather data and data balancing techniques did not greatly increase model performance. Creation of individualized models has the potential to increase predictive ability depending on data quality, but more research is needed to elucidate what impact this type of data can have on prediction of DNF.

