Using a Multiple Logistic Regression Model to Predict Prognosis of Cows With Right Abomasal Displacement or Abomasal Volvulus

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Introduction

To date, individual or pairs of physical and laboratory parameters have been used to predict the prognosis of cows with right abomasal displacement or volvulus (2,3,5-8). However, the use of individual parameters may be unreliable in prediction, and multivariable statistical modeling techniques can control some of the inherent problems associated with their use (4). Our objective was to develop a multiple logistic regression model for estimating outcome in cows after surgical correction of right abomasal displacement or abomasal volvulus.

Materials and Methods

Clinical, clinicopathologic and pathologic data were compiled from the medical records of adult cows admitted to the New York State College of Veterinary Medicine in the 8 year period (1980-1987) with a final diagnosis of right abomasal displacement or volvulus. Cows were classified as productive, salvaged or terminal based upon previously published criteria (8). The model for predicting postsurgical outcome was developed using SAS LOGIST (4) which fits the logistic multiple regression model (10) to a single binary dependent variable or to an original dependent variable using maximum likelihood method. The outcome (0 = productive, 1 = salvaged and 2 = terminal) was handled as an ordinal dependent variable. We used both the forward stepwise approach to consider each variable sequentially in relation to the other potentially significant variables, and the backward stepwise approach to confirm the best candidate models. In the reported models, we retained only those variables that were found to significantly affect outcome.

Results

The distribution of outcome for the 458 cows comprising the study population was: productive 346, (75.5%); salvaged 88, (19.2%); and terminal, 24 (5.2%). The admission model containing complete data from 346 cows was reduced to 3 variables: heart rate, base excess concentration (BE), and plasma Cl^- concentration ($R = 0.368$). The surgical model containing data from 335 cows was reduced to 5 variables: heart rate, BE, diagnosis, decompression used, and appearance of abomasal serosa ($R = 0.495$). Tests of goodness of fit comparing observed and predicted numbers indicated a high degree of fit for both admission and surgical models ($P = 0.876$ and $P = 0.970$, respectively).

Discussion

Logistic regression analysis has proven to be a useful statistical technique allowing simultaneous consideration of multiple explanatory variables when the response variable is dichotomous. Because in this study the response variable had 3 categories (productive, salvaged and terminal) to correspond to the biologic situation, we used a polychotomous extension of the usual logistic model rather than the binary situation. Though the admission model containing heart rate, pH, and Na^+ had a slighlty higher R value (0.387 versus 0.368) than the model containing heart rate, BE, and Cl^-, the latter was chosen for the final model because the agreement between predicted and observed values was better. Also, most surgeons are used to evaluating plasma Cl^- concentrations in cows with right abomasal displacement or abomasal volvulus, and both Cl^- and BE have previously been suggested as predictors for outcome (5,7,8). The model containing Na^+ was slightly better than the one with Cl^- because Na^+decreased in linear fashion with the severity of the disease while Cl^- increased terminally (1). The surgical model did not include either Na^+ or Cl^-, and the only choice was whether or not to include pH or BE. The model with BE had a slighly higher R value than the model with pH (0.495 vs 0.494). Though agreement between observed and predicted numbers in both the admission and surgical models

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was good, caution must be used in analyzing the results of the chi-square test because the expected number of observations in several cells was less than five (9).

The multiple logistic regression models developed in this study have several advantages over individual physical and laboratory parameters previously reported. They are useful to surgeons for objective decisions. However, the validation of the models and the economical decision strategy require further research.

Summary

Data at admission and at surgery were collected on 458 cows with right abomasal displacement or abomasal volvulus to derive multiple logistic regression models for predicting postsurgical outcome (productive, salvaged or terminal). Three admission variables (heart rate, base excess, and plasma chloride concentration), and five surgical variables (heart rate, base excess, diagnosis, method of decompression used, and appearance of abomasal serosa) were used in the final models. Predicted outcomes using the admission and surgical models were closely related with actual outcomes.

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