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USE OF PSEUDO-OBSERVATIONS IN THE GOODNESS-OF-FIT TEST FOR GRAY'S TIME-VARYING COEFFICIENTS MODEL

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Background

The Cox proportional hazards (PH) regression model is the most common method to estimate underlying survival or failure probabilities and to estimate the effects of covariates on survival times. In Cox PH models, the regression coefficients are assumed constant over time. However, if covariate effects vary over time, alternative models which do not necessarily assume proportionality are needed.

Method

We proposed the Gray's time-varying coefficient (TVC) method based on pseudo-observation. By using pseudo-observations, pseudo-residuals were calculated and plotted against the estimated survival rates at each of the nine selected time points, then were used to evaluate the goodness-of-fit of the Gray's model. We applied this method to assess the fit for a model that predicts post-transplant survival probability among children who were under the age of 12 years, had end-stage liver disease, and underwent liver transplantation between January 2005 and June 2010.

Result

For Gray's TVC model, through the first time point and the sixth time point, pseudo residual plots are around zero, while pseudo residual plots show slight departure at small values of estimated survival rate through the seventh time point and the ninth time point. Since the pseudo residual plots stay around zero at each time point without any significant departure or tendency, we can conclude that Gray's model shows a good fit in estimating survival function at each time point. The results from this real liver transplantation data demonstrate that the final Gray's model shows a good fit in estimating post-transplant survival.

Conclusion

When data violate the PH assumption, the Gray TVC model or an alternative should be used to obtain unbiased estimates on survival function and give correct inference on the relationship between potential covariates and survival. The proposed goodness-of-fit test offers a tool to investigate how well the model fits the data.