Propensity Score-Weighted Survival Model for the Benefit of Adjuvant Chemoradiotherapy for Gallbladder Cancer

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Abstract and Objective

The efficacy of adjuvant chemoradiotherapy for biliary tract cancers remains controversial due to the absence of large randomized clinical trials for this rare disease. Survival prediction models created using retrospective data analysis can help clinicians and patients assess the potential benefit of adjuvant chemoradiotherapy based on specific tumor and patient characteristics. In this work, we created a nomogram based on the Surveillance, Epidemiology, and End Results (SEER)-Medicare dataset. As analyses comparing the effectiveness of treatments on non-randomized groups can be subject to treatment-selection bias, we used propensity score weighting to adjust for the imbalance of the covariates between the treatment and control groups. Our nomogram and web-based tool can be used to help make individualized adjuvant treatment recommendations for gallbladder cancer patients.

Keywords:

Survival analysis, Nomograms.

Methods

We selected 1385 patients with resected gallbladder cancer diagnosed between 1995-2002 from the 2006 release of the SEER-Medicare database. Covariates used in the analysis included age, race, sex, stage, and histology. The outcome of interest was overall survival with and without adjuvant chemoradiotherapy (CRT).

In retrospective, non-randomized data series, there can be baseline differences in covariates between treated and untreated groups, as seen in Table 1. Propensity scores (PS) are an effective means for compensating for these differences. The propensity score is the conditional probability of receiving a treatment given the baseline covariates and has the important property that the treated and untreated subjects with the same propensity score will have similar distribution of observed baseline covariates. In this analysis, we used PS weighting to balance the treatment and control groups. A Cox proportional hazards (CPH) multivariate regression model was constructed. The model was internally validated for both discrimination and calibration using a bootstrap resampling technique.

Table 1 – Comparison of Covariates with and without PS Weighting

	Unbalanced			PS Weighted		
Covariate	**Trt**	**Ctrl**	**p**	**Trt**	**Ctrl**	**p**
Age*	72.7	75.0	0.004	72.7	72.7	0.981
Sex	0.77	0.74	0.54	0.77	0.77	0.97
race:	0.83	0.81	0.917	0.83	0.82	0.685
tStage	0.13	0.24	0.135	0.13	0.13	1
nStage*	0.45	0.27	0.028	0.45	0.45	0.965

Results

Table 1 shows how the PS weighting balances the covariates between treated and untreated patients. The CPH survival prediction model demonstrated good discrimination with a bootstrap-corrected concordance index of 0.673. A calibration curve showed good calibration between predicted and actual survival at 5 years. A nomogram and a browser-based software tool were built from the model that allows users to enter specific patient data and obtain survival predictions. The model predicts that certain patients with node positive, advanced stage disease will yield a survival benefit from adjuvant CRT, although the magnitude of benefit for any individual patient can vary.

Conclusions

A nomogram based on the SEER-Medicare database can be used to make predictions of the expected survival benefit from adjuvant CRT for patients with resected gallbladder cancer. This tool can be used to help make individualized adjuvant treatment recommendations for gallbladder cancer patients.