Data Science Clinic: Neurocritical Care Winter 2023 One-Pager

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Problem Overview

Neurologists specializing in brain trauma typically treat penetrating brain injuries with a number of specific procedures. It is difficult and ethically precarious to conduct a randomized control trial with these procedures. University of Chicago Medicine (UCM) tasked the clinic team with leveraging causal inference to explore the relationship between these procedures and favorable outcomes using already-existing data, sourced from the National Trauma Data Bank, the Trauma Quality Improvement Program, the International Classification of Diseases, and the Association for the Advancement of Automotive Medicine.

Data Science Clinic Team Contribution

First, the clinic team identified a cohort of patients eligible for the simulated controlled study by filtering the data to eliminate patients who did not meet UCM's inclusion criteria. (Fig. 1) The team also cleaned the data by standardizing data types and created a binary outcome metric. The team then calculated propensity scores as a metric to simulate randomization. The team used inverse propensity scores as weights in a Logistic Regression model, which allowed them to partially simulate the randomization process that ordinarily allows researchers to make causal inferences.

Results

The team discovered that, when confounding variables are accounted for in the final model, individuals with the procedure are about 19.8% more likely to have a favorable outcome than individuals who did not receive the procedure. Further, this result was not statistically significant. However, as researchers at UCM explained, the double-inclusion of confounding variables in both the propensity score calculation and the final model may not be necessary. Including confounding variables in the propensity score calculations controls for the non-random distribution of these variables into the control and treatment groups. When these confounders are not included in the final model —– and only included in the propensity score calculation — individuals with the procedure are 5.95 times more likely to have a favorable outcome than individuals in the control group. This result was statistically significant. To understand the correlations between the variables, we produced a heatmap which demonstrated negative correlations between every variable when paired with another.

	Overall	Brain Surgery	No Brain Surgery
Number of Patients	2293	400	1893
Age, mean (SD)	35.7 (15.5)	32.1 (14.5)	36.4 (15.7)
Heart Rate, mean (SD)	92.5 (26.1)	92.7 (28.5)	92.4 (25.6)
Sex, n (%)			
Male	1904 (83%)	331 (14%)	1573 (68%)
Female	338 (16.9%)	69 (3%)	319 (13.9%)

Fig. 1 Summary statistics of patients qualifying for inclusion in the study

Impact

The clinic team was not able to unequivocally demonstrate that the procedure causes favorable outcomes. Nevertheless, the clinic team demonstrated that the procedures under question were associated with better outcomes. The results lean towards the conclusion that the procedure may cause better outcomes, although further research is needed to fully answer this question.