Predicting Vasospasm After Subarachnoid Hemorrhage Using High-Frequency Physiological Data

Soojin Park, Columbia University; *Murad Megjhani, Columbia University Department of Neurology; Hans-Peter Frey, Columbia University Department of Neurology; Edouard Grave, Facebook AI Research Group (all work done while postdoctoral fellow at Columbia University Department of Biomedical Informatics); Chris Wiggins, Columbia University Department of Applied Physics and Applied Mathematics; Noemie Elhadad, Columbia University Department of Biomedical Informatics*

Objective

To examine whether patterns within time series data are superior to static admission grading scales for predicting delayed cerebral ischemia (DCI) after subarachnoid hemorrhage (SAH). Consecutive admissions for spontaneous SAH were enrolled in an outcomes study at a tertiary care neuroICU. 390 patients met inclusion criteria. Baseline information and grading scales were evaluated including age, gender, Hunt Hess grade, Modified Fisher scale (MFS), and Glasgow coma scale. An unsupervised approach called Random Kitchen Sink (RKS) extracted features from a universal physiological time series dataset (systolic and diastolic blood pressure, heart rate, respiratory rate, and oxygen saturation). Three different classifiers (Partial Least Squares, Support Vector Machines linear, and Support Vector Machines kernel) were trained using subsets of features: (1) MFS (AUC 0.57), (2) baseline information and grading scales (AUC 0.62), (3) RKS-derived physiologic features (AUC 0.74), and (4) combined baseline information, grading scales, and RKS-derived physiologic features with redundant feature reduction (AUC 0.78). For generalizability, analyses were repeated with less restrictive inclusion criteria with total of 488 patients, and results were as good with an AUC of 0.77. Performance is reported as medians on cross-validation with a 12.5% proportional hold-out set.

Conclusions

After spontaneous SAH, patients are monitored for DCI for up to 14 days. Current prediction tools rely on blood thickness and distribution on admission imaging. While advantageously simple to employ, the MFS predicted DCI in our cohort with an AUC of only 0.57. Adding demographics and other grading scales improved prediction accuracy slightly to AUC 0.62. Adding high-frequency features from a universally obtained physiologic dataset further improved prediction accuracy for DCI to AUC 0.78. With an abundance of data and growing ability for data acquisition and online analysis, there is an opportunity to improve an individual's risk assessment.