# Predicting Delayed Cerebral Ischemia (DCI) using Sequential Patterns in Plethysmography Data

Type:

Abstract

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Introduction/Hypothesis:

DCI, a complication of subarachnoid hemorrhage (SAH), can lead to functional and cognitive disability. Early prediction of DCI allows timely treatment to enable favorable patient outcomes. We hypothesize that the sequential patterns that manifest in patients' physiologic waveform data collected in the Neurological Intensive Care Unit (NICU) can be indicative of impending DCI and leveraged for early prediction.

Methods:

12 of 29 SAH patients admitted to the NICU developed DCI (neurologic deterioration plus abnormal cerebral perfusion on transcranial Doppler, head CT or cerebral angiography) and were identified as the positive class in our sample. Static features: age, gender, Hunt Hess grade, Fisher Scale, and Glasgow Coma Scale were collected on admission. Finger plethysmography was monitored at 125Hz. The first monitoring hour from admission was excluded from analysis due to instabilities at monitoring onset. Since interventions for DCI usually require <1 hour to implement, a 6-hour segment 1 hour before DCI onset was extracted for positive cases, and moving mean and standard deviation were computed each minute. A matching segment during the third to eighth monitoring hours was featurized in the same way for the controls. All moving statistics were normalized with baseline computed from the second monitoring hour. Sequential patterns were extracted from the resulting moving statistics using Graphs of Temporal Constraints (GTC) algorithm, and a decision forest model (GTC-DF) was then trained from data to predict DCI.

Results:

Evaluated using leave-one-patient-out cross-validation, GTC-DF identified 1/3 of DCI cases at very low false positive rate (1 false alert in 10,000 predictions on average), and achieved Area under Receiver Operating Characteristic (AUC) of 0.674. It outperformed classifiers trained using static, non-sequential features: Logistic Regression (AUC 0.431), K-Nearest Neighbors (AUC 0.532), and Support Vector Machine with RBF kernel (AUC 0.480).

Conclusions:

By leveraging sequential patterns in physiologic waveform data collected at the bedside, it is possible to confidently identify 1/3 of SAH patients who are likely to develop DCI one hour before its onset. This can inform their timely treatment and reduce adverse outcomes.
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