Machine learning for Aneurysmal subarachnoid hemorrhage outcome prediction

- Comprehensive predictive modeling in subarachnoid hemorrhage: integrating radiomics and clinical variables
- Development of a non-contrast CT-based radiomics nomogram for early prediction of delayed cerebral ischemia in aneurysmal subarachnoid hemorrhage
- Evaluation of cerebral blood flow after subarachnoid hemorrhage using near-field coupling and machine learning
- State-of-the-art for automated machine learning predicts outcomes in poor-grade aneurysmal subarachnoid hemorrhage using routinely measured laboratory & radiological parameters: coagulation parameters and liver function as key prognosticators
- Development and Validation of Machine Learning Models for Outcome Prediction in Patients with Poor-Grade Aneurysmal Subarachnoid Hemorrhage Following Endovascular Treatment
- Machine Learning in Predicting the Cognitive Improvement of Ventriculoperitoneal Shunt for Chronic Normal Pressure Hydrocephalus After Aneurysmal Subarachnoid Hemorrhage
- Retrospective cohort study based on the MIMIC-IV database: analysis of factors influencing all-cause mortality at 30 days, 90 days, 1 year, and 3 years in patients with different types of stroke
- Systemic Metabolic Alterations after Aneurysmal Subarachnoid Hemorrhage: A Plasma Metabolomics Approach

The algorithm was trained based upon age, sex, hypertension (HTN), diabetes, hyperlipidemia, congestive heart failure, coronary artery disease, smoking history, family history of aneurysm, Fisher Grade, Hunt and Hess score, and external ventricular drain placement. Random Forest was selected for this project, and prediction outcome of the algorithm was delayed cerebral ischemia+. SHapley Additive exPlanations was used to visualize each feature's contribution to the model prediction.

Results: The Random Forest machine learning algorithm predicted delayed cerebral ischemia: accuracy 80.65% (95% CI: 72.62-88.68), area under the curve 0.780 (95% CI: 0.696-0.864), sensitivity 12.5% (95% CI: -3.7 to 28.7), specificity 94.81% (95% CI: 89.85-99.77), PPV 33.3% (95% CI: -4.39 to 71.05), and NPV 84.1% (95% CI: 76.38-91.82). SHapley Additive exPlanations value demonstrated Age, external ventricular drain placement, Fisher Grade, and Hunt and Hess score, and HTN had the highest predictive values for delayed cerebral ischemia. Lower age, absence of hypertension, higher Hunt and Hess score, higher Fisher Grade, and external ventricular drain placement increased risk of delayed cerebral ischemia.

Conclusion: Machine learning models based upon clinical variables predict delayed cerebral ischemia with high specificity and good accuracy [1].

A presented ffANN showed equal performance when compared with VASOGRADE and Subarachnoid Hemorrhage International Trialists (SAHIT) scoring systems while using less individual cases. The web interface launched simultaneously with the publication of this manuscript allows for usage of the ffANN-based prediction tool for individual data (https://nutshell-tool.com/) [2].

1)

Taghavi RM, Zhu G, Wintermark M, Kuraitis GM, Sussman ES, Pulli B, Biniam B, Ostmeier S, Steinberg GK, Heit JJ. Prediction of delayed cerebral ischemia after cerebral aneurysm rupture using explainable machine learning approach. Interv Neuroradiol. 2023 Apr 17:15910199231170411. doi: 10.1177/15910199231170411. Epub ahead of print. PMID: 37070145.

2)

de Jong G, Aquarius R, Sanaan B, Bartels RHMA, Grotenhuis JA, Henssen DJHA, Boogaarts HD. Prediction Models in Aneurysmal Subarachnoid Hemorrhage: Forecasting Clinical Outcome With Artificial Intelligence. Neurosurgery. 2021 Apr 15;88(5):E427-E434. doi: 10.1093/neuros/nyaa581. PMID: 33548918.