



A Random Forest Classifier for Predicting Cerebral Vasospasm Following Subarachnoid Hemorrhage



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Background

Cerebral vasospasm is a life-threatening phenomenon in patients following subarachnoid hemorrhage [1].

Subarachnoid hemorrhage patients are routinely monitored in the ICU for 2-3 weeks [2] post-bleed because **current tech cannot determine which patients will develop vasospasm.**

Objectives

To predict severe cerebral vasospasm warranting verapamil administration using machine learning and routinely monitored clinical values.

Methods

Extracted demographics, verapamil injection times, and clinical values of interest from the Perioperative Data Warehouse for ICU patients at our institution between 2013 and 2021.

Clinical values included blood pressure, laboratory sera including sodium, albumin, hemoglobin, glucose, creatinine, potassium, and chloride, and intracranial pressure.

Trained random forest classifiers to predict injection of verapamil based on time-series of each clinical value.

Five-fold cross validation was implemented to calculate five **ROC curves and AUCs** for each clinical value at various times before injection.

Results

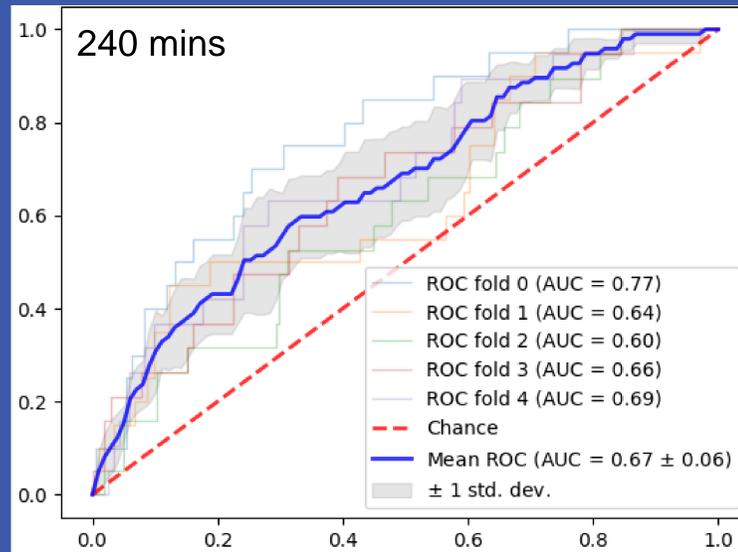


Figure 1a. Blood pressure receiver operator characteristic curves for five-fold cross validation at 240 minutes prior to verapamil injection.

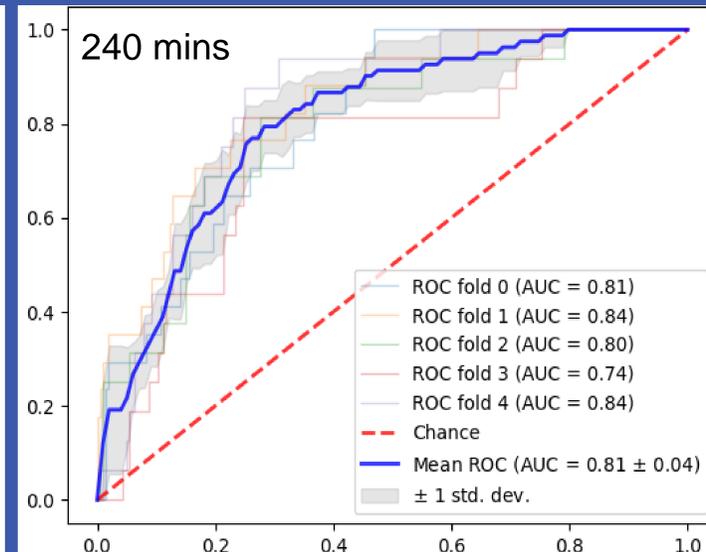


Figure 1b. Intracranial pressure receiver operator characteristic curves for five-fold cross validation at 240 minutes prior to verapamil injection.

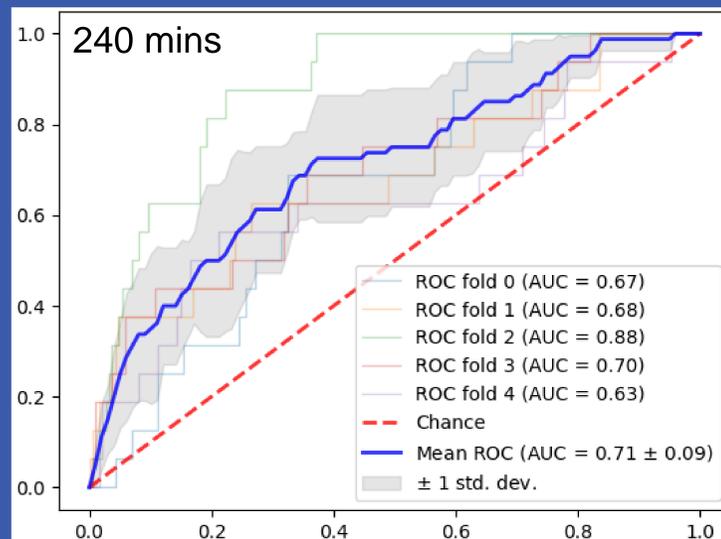


Figure 1c. Laboratory sera receiver operator characteristic curves for five-fold cross validation at 240 minutes prior to verapamil injection.

Time before Verapamil Injection	Mean AUC			Sample size: verapamil / no verapamil
	BP	ICP	Lab Sera	
240 mins	0.67	0.81	0.71	82/1027
720 mins	0.67	0.83	0.72	81/1027
1440 mins	0.6	0.82	0.71	80/1027
2160 mins	0.63	0.83	0.69	79/1027
2880 mins	0.63	0.8	0.72	77/1027
3600 mins	0.6	0.8	0.72	75/1027
4320 mins	0.62	0.79	0.74	72/1027

Table 1. AUCs and sample sizes for each predictive model.

Table 1. Sample sizes and areas under the receiver operator curve for each model input parameter at each prediction time interval prior to verapamil injection.

Conclusions

Intracranial pressure is a strong predictor of severe cerebral vasospasm needing verapamil injection up to three days prior to verapamil injection using a random forest classifier.

The same model using blood pressure and laboratory sera yielded less predictive power.

Limitations

This study was performed on a cohort from a single institution. Additionally, our model predicts the injection of verapamil, rather than the physiologic occurrence of cerebral vasospasm.

Future Directions

Test model performance in a multi-institutional study.

Eventually test model in clinical setting at our institution.

References

1. Dhar R, Scalfani MT, Blackburn S, Zazulia AR, Videen T, Diring M. Relationship between angiographic vasospasm and regional hypoperfusion in aneurysmal subarachnoid hemorrhage. *Stroke*. 2012;43(7):1788-1794.
2. Collins CI, Hasan TF, Mooney LH, et al. Subarachnoid Hemorrhage "Fast Track": A Health Economics and Health Care Redesign Approach for Early Selected Hospital Discharge. *Mayo Clin Proc Innov Qual Outcomes*. 2020;4(3):238.