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Predicting Risk of Neurologic Patient Readmission

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# Predicting Risk of Neurologic Patient Readmission

Validating and Improving the Neuro  $R^2$  Score

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## Introduction

- Approximately two million hospital readmissions occur annually and cost Medicare nearly \$26 billion dollars[1].
- The Neuro  $R^2$  score was designed by the Mayo Clinic to predict the risk of readmission within 30 days of recent hospitalization in patients with neurological disorders and based on common clinical characteristics[2][3].
- It remains unknown whether the prediction model is broadly applicable, particularly when incorporating patient characteristics strongly associated with healthcare disparities[1].

## Objective

To test the performance by external validation of the Neuro  $R^2$  score and develop an independent machine learning model that accounts for readmission disparities.

## Design/Methods

- Retrospective analysis of 4,117 admitted patients with neurological disease at the University of California Davis Medical Center between June 2016 to March 2020.
- This study compares three different machine learning models:

	Model Creator	Data Used for Training
Neuro $R^2$ Score	Mayo Clinic	Mayo Clinic Patients
Refitted Neuro $R^2$ Model	Mayo Clinic	UC Davis Patients
UC Davis Model	UC Davis	UC Davis Patients

## Results

- 310 of 4,117 patients (7.5%) were readmitted within 30 days of a prior neurologic admission
- The UC Davis Model outperformed both the Neuro  $R^2$  Score and Refitted Neuro  $R^2$  Model

	Average Precision	C statistic
Neuro $R^2$ Score	0.11	0.56
Refitted Neuro $R^2$ Model	0.17	0.67
UC Davis Model	0.20	0.70

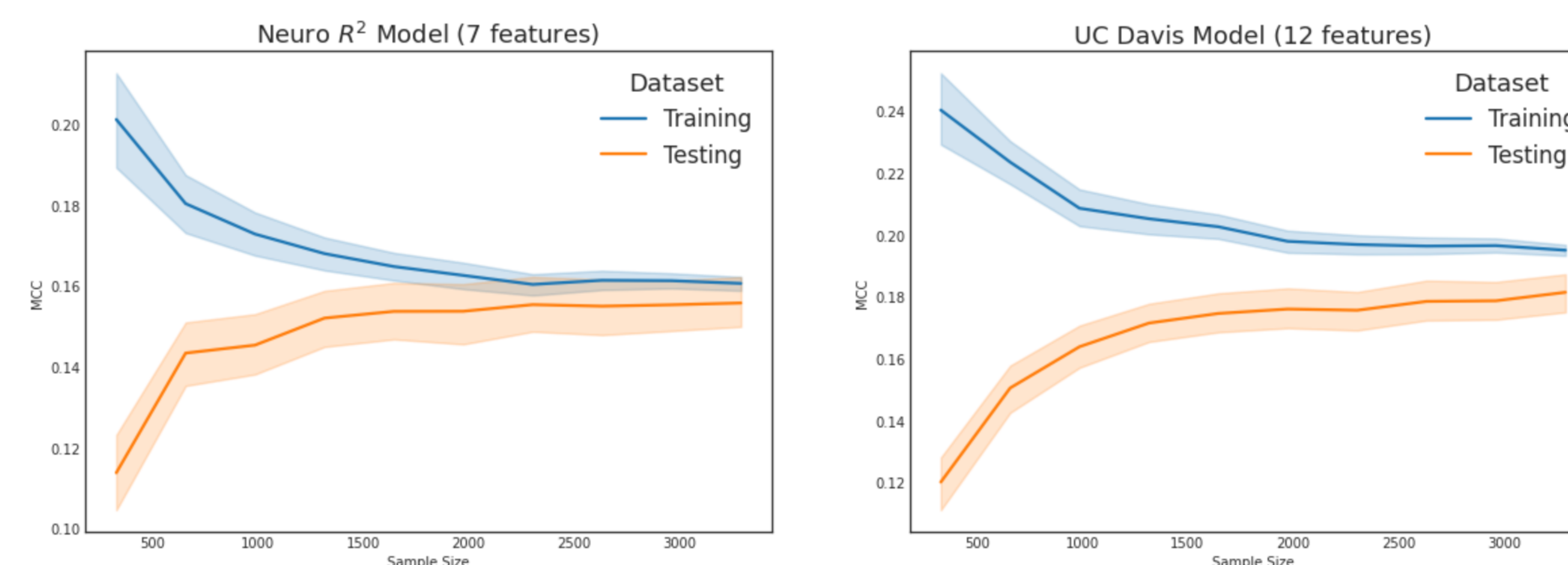
## Neuro $R^2$ Model Trained with Mayo vs UC Davis Patient Data

- UC Davis patients with cerebrovascular disease or discharged to rehab were *less likely* to be readmitted
- Most Mayo features were statistically insignificant at UC Davis

Effect	Odds Ratio		Pr < $\chi^2$	
	Mayo	Davis	Mayo	Davis
Charlson disease count	1.20	1.21	0.005	<0.001
Urgent/emergent admission	1.50	1.07	0.03	0.058
Discharge to rehabilitation	1.66	0.90	0.005	0.002
Charlson-cancer (not metastatic)	1.70	1.02	0.007	0.625
Brain tumor	1.82	1.03	0.03	0.379
Charlson-cerebrovascular disease	2.18	0.379	<0.001	0.008
Discharge to SNF	2.43	1.04	<0.001	0.242

## Neuro $R^2$ Model Bias

- The Neuro  $R^2$  training and test performance overlap at 1,700 samples showing it to have a high bias
- Biased models can be improved by adding features, in this case patient characteristics

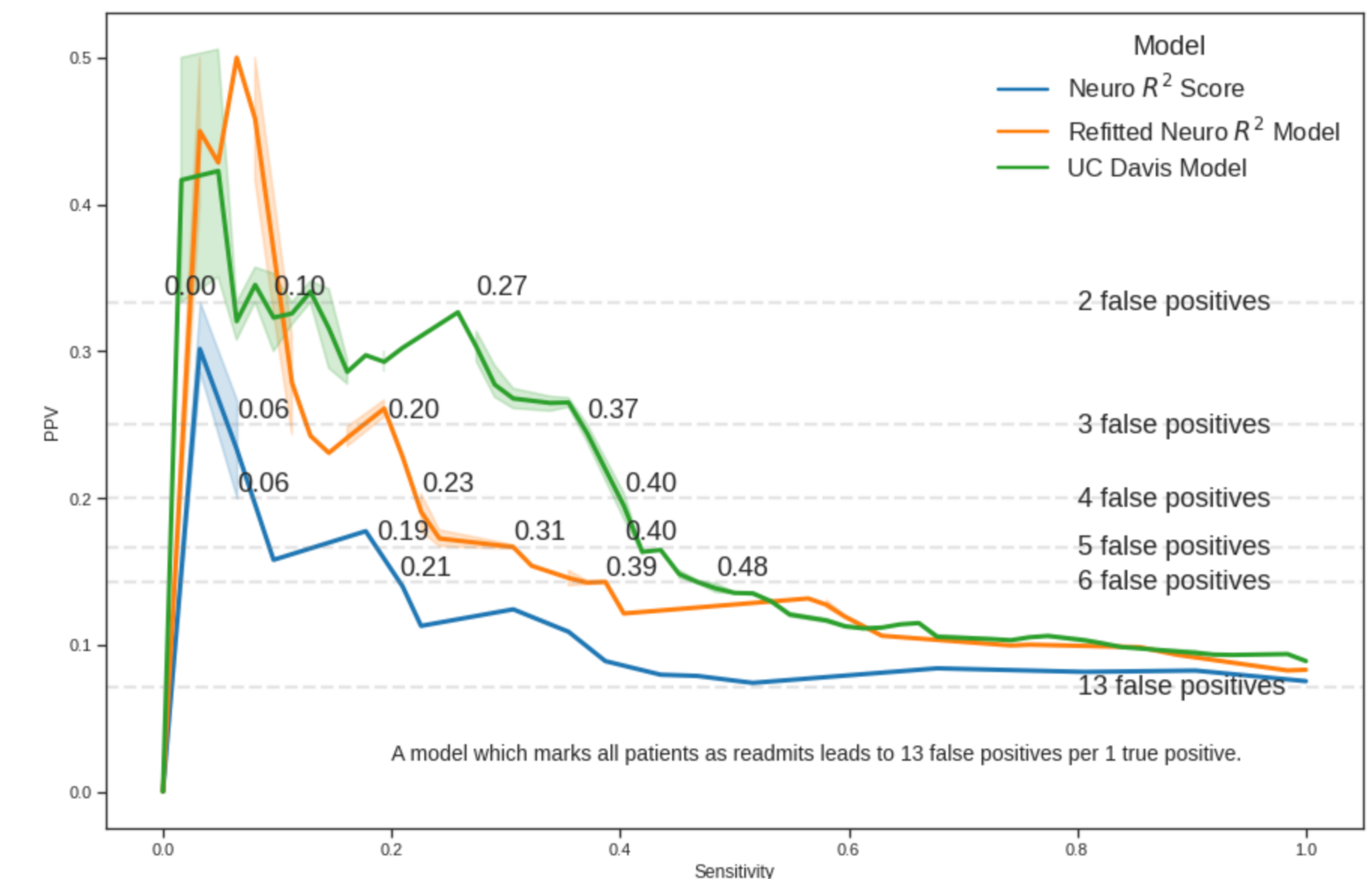


## Selecting Patient Features for the UC Davis Model

Relief-based feature selection organizes patients into “neighborhoods” based on similar characteristics and then finds differences which are most associated with readmission[4]

Increased Readmission Risk	Decreased Readmission Risk
Charlson disease count	Commercial PPO coverage
Primary Dx of trauma or MSK	Medicare Managed Care coverage
Malignant neoplasm of the brain	Discharge to Rehabilitation
Admitted through ER	
Discharged to SNF or Home Health	
Medicaid Managed Care coverage	
African American Race	

## Sensitivity and Positive Predictive Value of Models



## Conclusion

- The Neuro  $R^2$  score poorly predicted the risk of readmission in our sample population at an urban academic tertiary referral center
- Adding race, insurance status, and recovery intervention features to our machine learning model enabled it to outperform the Neuro  $R^2$  score.

## Further Reading

To learn more, visit <https://bit.ly/39NjFwY>.

## References

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