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Use of Machine Learning Models to Identify Atherosclerotic Cardiovascular Disease Patients at Very High Risk for Future Events in a Multi-state Health Care System

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Background

- The 2018 AHA/ACC Blood Cholesterol Guideline recommendation to classify ASCVD patients as very high-risk (VHR) vs. not-VHR (NVHR) has important treatment implications¹

Objective

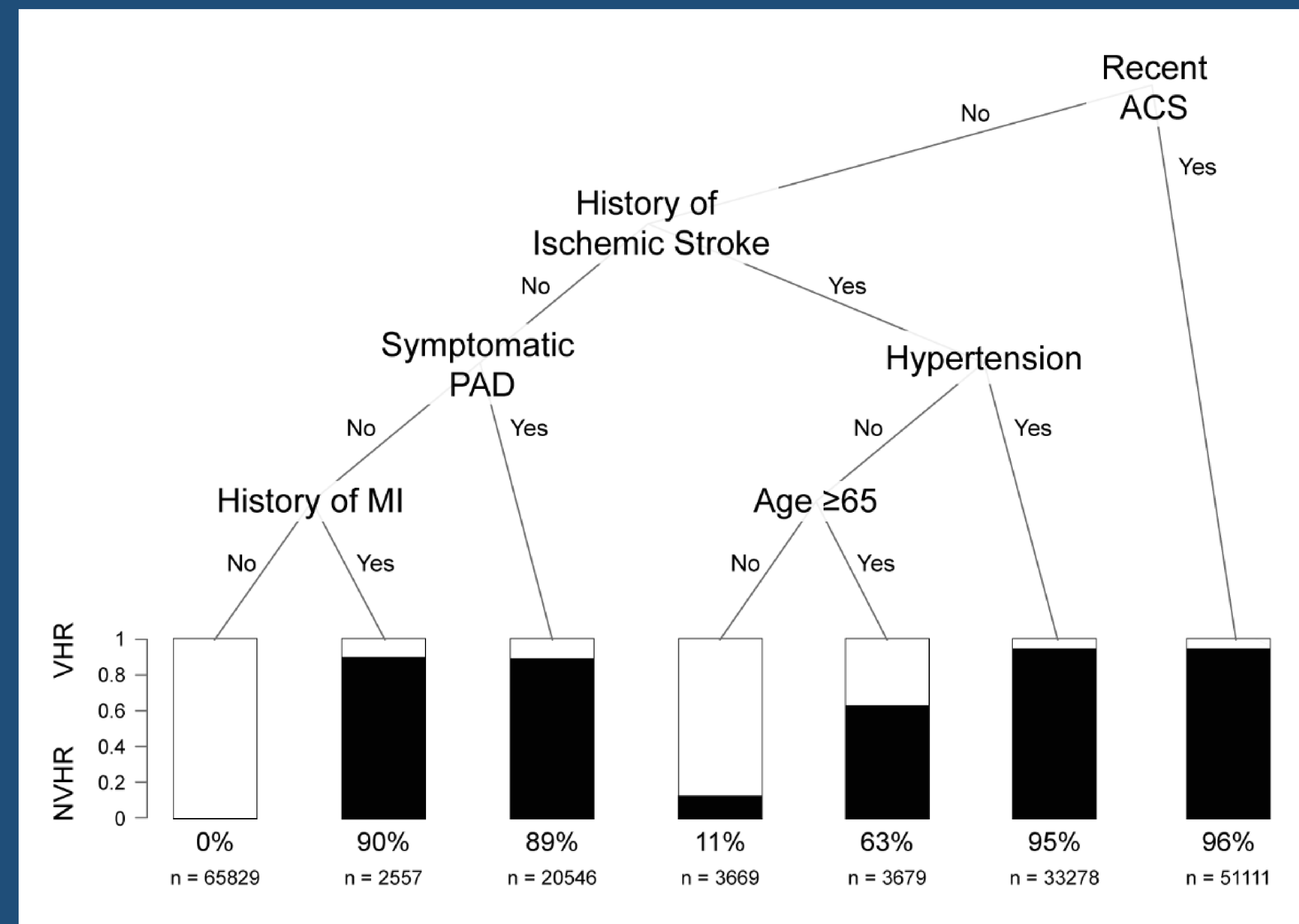
- Develop a simple tool to assist clinicians in identifying VHR patients based on machine learning (ML) techniques

Methods

- Retrospective cohort analysis of ASCVD patients in the Providence St. Joseph Health (PSJH) system (28 hospitals) in 2018
- ICD-10 codes derived from the EHR were used to define the population
- VHR was defined by ≥ 2 major ASCVD events or 1 major ASCVD event and ≥ 2 high-risk conditions; patients not meeting these criteria were classified as NVHR (Table 1)
- Classification and regression tree (CART) modeling were performed on training (n=90,334) and validation (n=90,335) datasets, with results compared with a random forest model
- Variables in the models included age, sex, race, ethnicity, and each of the VHR criteria defined above
- The primary outcome for both models was VHR status



Using machine learning techniques, recent ACS or ischemic stroke plus hypertension predicted very high-risk status in 96% and 95% of ASCVD patients, respectively



Classification and regression risk prediction tree for ASCVD patients at very high-risk

Results

Table 1: Very High Risk and Not Very High Risk Characterization

Variable	Overall Population (n=180,669)	Very High-Risk (n=104,123)	Not Very High-Risk (n=76,546)	% with event or condition that are VHR
Age, yrs	72 ± 13	73 ± 12	70 ± 13	
Male	99365 (55)	57769 (55)	41596 (54)	
White	152925 (92)	87096 (91)	65829 (93)	
Major ASCVD events				
Recent ACS*	51111 (28)	49143 (47)	1968 (3)	96
History of MI†	40444 (22)	40186 (39)	258 (0.3)	99
History of ischemic stroke	49305 (27)	43117 (41)	6188 (8)	87
Symptomatic PAD	30010 (17)	27707 (27)	2303 (3)	92
High-risk conditions				
Age ≥65 years	134391 (74)	81951 (79)	52440 (69)	61
HeFH	3840 (2.1)	2477 (2.4)	1363 (1.8)	65
Prior PCI or CABG	23181 (13)	14680 (14)	8501 (11)	63
Diabetes	61293 (34)	40747 (39)	20546 (27)	66
Hypertension	145677 (81)	92205 (89)	53472 (70)	63
CKD	3572 (2.0)	2321 (2.2)	1251 (1.6)	65
Current smoker	59016 (33)	38566 (37)	20450 (27)	65
Persistently elevated LDL-C	1566 (0.9)	1000 (1.0)	566 (0.7)	64
History of CHF	42694 (24)	30199 (29)	12495 (16)	71

Data presented as n (%) or mean ± SD

*Within 12 months

†Outside the ACS event

ACS = acute coronary syndrome, ASCVD = atherosclerotic cardiovascular disease, CABG = coronary artery bypass graft, CHF = congestive heart failure, CKD = chronic kidney disease, HeFH = heterozygous familial hypercholesterolemia, LDL-C = low-density lipoprotein cholesterol, MI = myocardial infarction, PAD = peripheral artery disease, PCI = percutaneous coronary intervention, VHR = very high-risk

- Of 180,669 ASCVD patients identified, 104,123 (58%) were VHR and 76,546 (42%) were NVHR
- CART and random forest models identified recent ACS, ischemic stroke, hypertension, PAD, and history of MI as the top five predictors of VHR status
- The CART model's misclassification rate was 4.3%; AUC for the CART and random forest models was 0.949 and 0.968, respectively

Conclusions

- ML methods employed to predict VHR status can simplify clinical decision making at the point of care

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References: 1. Grundy SM, et al (2019) JACC

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