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Weekend Carotid Revascularization Is Associated with Increased Perioperative Complications and Mortality: A Vascular Quality Initiative Analysis

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Objectives: Open surgical treatment options for aortoiliac occlusive disease carry significant perioperative risks; however, outcome prediction tools remain limited. Using machine learning (ML), we developed automated algorithms that predict 30-day outcomes following open aortoiliac revascularization.

Methods: In this multicenter retrospective cohort study, the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) targeted database was used to identify patients who underwent open aortoiliac revascularization for atherosclerotic disease between 2011 and 2021. Patients treated for aneurysmal disease, acute limb ischemia, trauma, dissection, or malignancy were excluded. Input features included 38 preoperative demographic/clinical variables. The primary outcome was 30-day major adverse limb event (MALE; composite of untreated loss of patency, major reintervention, or major amputation) or death. The 30-day secondary outcomes were individual components of the primary outcome, major adverse cardiovascular event, wound complication, bleeding, other morbidity, non-home discharge, and unplanned readmission. Our data were split into training (70%) and test (30%) sets. Using 10-fold cross-validation, we trained 6 ML models using preoperative features. The primary model evaluation metric was area under the receiver operating characteristic curve (AUROC). Model robustness was evaluated with calibration plot and Brier score. Variable importance scores were calculated to determine the top 10 predictive features. Performance was assessed on subgroups based on age, sex, race, ethnicity, symptom status, procedure type, and urgency.

Results: Overall, 9649 patients were included. Thirty-day MALE or death occurred in 1021 patients (10.6%). Those with a primary outcome were older with more comorbidities, had poorer functional status, and were more likely to have high-risk physiologic and anatomic features, yet a lower proportion were on antiplatelets/statins. Our best performing prediction model for 30-day MALE or death was XGBoost, achieving an AUROC of 0.95 (95% confidence interval [CI], 0.94-0.96) (Fig 1). In comparison, logistic regression had an AUROC of 0.79 (95% CI, 0.77-0.81). For 30-day secondary outcomes, XGBoost achieved AUROCs between 0.87 and0.97. The calibration plot showed good agreement between predicted and observed event probabilities with a Brier score of 0.05 (Fig 2). The strongest predictive feature in our algorithm was symptom status (chronic limb-threatening ischemia). Model performance remained robust on all subgroup analyses of specific demographic and clinical populations.

Conclusions: Our ML models accurately predict 30-day outcomes following open aortoiliac revascularization using preoperative data, performing better than logistic regression. They have potential for important utility in guiding risk mitigation strategies for patients being considered for open aortoiliac revascularization to improve outcomes and reduce costs.

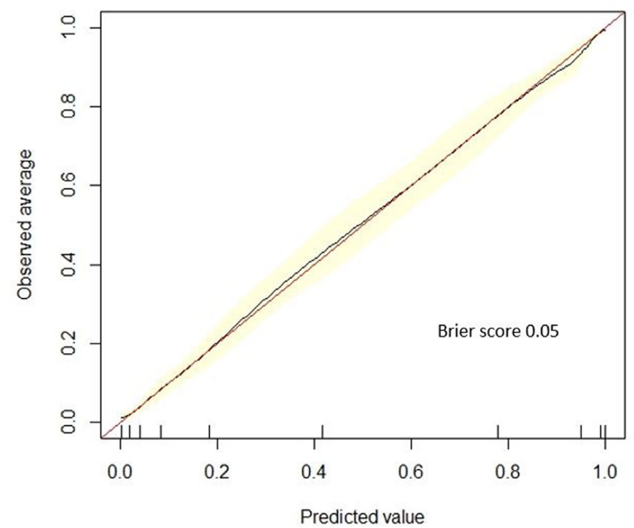

Fig 2. Calibration plot with Brier score for predicting 30-day major adverse limb event (*MALE*) or death following open aortoiliac revascularization using Extreme Gradient Boosting (XGBoost) model.

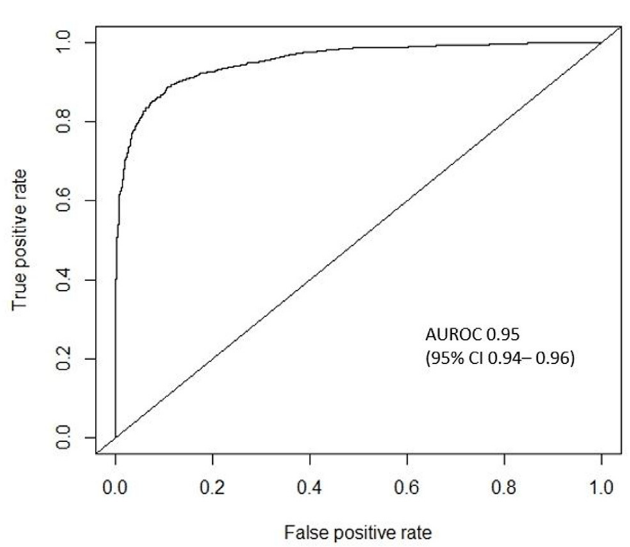

Fig 1. Receiver operating characteristic curve for predicting 30-day major adverse limb event or death following open aortoiliac revascularization using Extreme Gradient Boosting (XGBoost) model. *AUROC,* Area under the receiver operating characteristic curve; *CI,* confidence interval.

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INTERACTIVE POSTER SESSION

IP183

Differential Outcomes in Peri-perative Complications and Mortality for Weekend vs Weekday Carotid Revascularization: A Retrospective Vascular Quality Initiative Analysis

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Objectives: Outcomes for surgical interventions conducted over the weekend are associated with higher rates of mortality and complications when compared with weekday interventions. Although investigations have been performed on the 'weekend effect' for carotid endarterectomy (CEA), this association remains unclear for transcarotid artery revascularization (TCAR) and transfemoral carotid artery stenting (TFCAS). Our study aimed to evaluate whether weekend procedures are associated with increased mortality and complications for all three carotid revascularization methods.

Methods: We retrospectively queried the Vascular Quality Initiative for all patients undergoing CEA, TCAR, and TFCAS between 2016 and 2022. χ^2 and logistic regression modeling analyzed differences for primary outcomes including rates of in-hospital stroke, death, myocardial infarction, and 30-day mortality by weekend vs weekday intervention. Logistic models were adjusted for ethnicity, race, gender, age, symptomatic

Table I. Univariate analysis and multivariate logistic regression model — perioperative complications and mortality by procedure type.

Variable	Univariate analysis: Weekday procedure, No. (%)	Univariate analysis: Weekend procedure, No. (%)	Univariate analysis: *P*-value	Multivariate logistic regression model: OR (95% CI)	Multivariate logistic regression model: *P*-value
CEA					
In-hospital stroke	**1156 (1.1)**	**50 (2.5)**	**<.001[a]**	1.24 (0.93-1.66)	.136
In-hospital death	**306 (0.3)**	**16 (0.8)**	**<.001[a]**	1.24 (0.71-2.16)	.442
In-hospital MI	**634 (0.6)**	**25 (1.3)**	**<.001[a]**	**1.62 (1.06-2.50)**	**.027[a]**
In-hospital stroke/death	**1348 (1.3)**	**61 (3.1)**	**<.001[a]**	1.25 (0.97-1.62)	.089
In-hospital stroke/death/MI	**1895 (1.9)**	**80 (4.0)**	**<.001[a]**	**1.31 (1.04-1.65)**	**.024[a]**
30-day mortality	**703 (0.7)**	**29 (1.5)**	**<.001[a]**	1.12 (0.75-1.67)	.590
TCAR					
In-hospital stroke	432 (1.4)	3 (1.2)	.834	0.50 (0.18-1.40)	.185
In-hospital death	**138 (0.4)**	**4 (1.6)**	**.006[a]**	1.97 (0.74-5.24)	.172
In-hospital MI	163 (0.5)	1 (0.4)	.810	0.74 (0.11-4.82)	.755
In-hospital stroke/death	519 (1.7)	7 (2.9)	.145	0.96 (0.45-2.04)	.913
In-hospital stroke/death/MI	654 (2.1)	8 (3.3)	.197	0.95 (0.45-2.01)	.898
30-day mortality	**256 (0.8)**	**7 (2.9)**	**<.001[a]**	2.21 (0.99-4.95)	.052
TFCAS					
In-hospital stroke	**373 (1.9)**	**32 (3.9)**	**<.001[a]**	1.28 (0.88-1.87)	.199
In-hospital death	**229 (1.2)**	**54 (6.6)**	**<.001[a]**	**1.91 (1.31-2.81)**	**.001[a]**
In-hospital MI	**93 (0.5)**	**12 (1.5)**	**<.001[a]**	1.68 (0.76-3.69)	.200
In-hospital stroke/death	**555 (2.8)**	**70 (8.6)**	**<.001***	**1.43 (1.06-1.94)**	**.020[a]**
In-hospital stroke/death/MI	**630 (3.2)**	**78 (9.6)**	**<.001***	**1.46 (1.09-1.96)**	**.012[a]**
30-day mortality	**376 (1.9)**	**70 (8.5)**	**<.001[a]**	**1.72 (1.25-2.37)**	**.001[a]**

CEA, Carotid endarterectomy; *CI*, confidence interval; *MI*, myocardial infarction; *OR*, odds ratio; *TCAR*, transcarotid artery revascularization; *TFCAS*, transfemoral carotid artery stenting.
Bold values indicate statistically significant variable associations ($P < .05$).
[a]Reported in the above Table, are primary outcome univariate analyses as well as ORs with accompanying 95% CIs from logistic regression models that have been adjusted for ethnicity, race, gender, age, symptomatic status, American Society of Anesthesiologists classification, hypertension, diabetes, anesthesia type, statin use, and glomular filtration rate.

Table II. Multivariate analysis comparing primary outcomes of three carotid revascularization methods performed on the weekend

	Outcomes	TCAR vs CEA: OR (95% CI)	TCAR vs CEA: *P*-value	TFCAS vs CEA: OR (95% CI)	TFCAS vs CEA: *P*-value	TFCAS vs TCAR: OR (95% CI)	TFCAS vs TCAR: *P*-value
Weekend procedures	In-hospital stroke	0.56 (0.19-1.66)	.297	**1.88 (1.01-3.49)**	**.046**	**3.72 (1.10-12.53)**	**.034**
	In-hospital death	1.97 (0.64-6.07)	.237	**6.83 (3.48-13.40)**	**<.001**	**2.94 (1.01-8.57)**	**.048**
	In-hospital MI	0.32 (0.04-2.34)	.263	1.10 (0.53-2.27)	.802	4.19 (0.70-25.02)	.116
	In-hospital stroke/death	0.92 (0.40-2.10)	.841	**2.38 (1.56-3.61)**	**<.001**	**2.61 (1.12-6.10)**	**.027**
	In-hospital stroke/death/MI	0.79 (0.35-1.79)	.569	**2.04 (1.38-3.00)**	**<.001**	**2.88 (1.24-6.73)**	**.014**
	30-day mortality	1.90 (0.74-4.88)	.180	**5.19 (3.10-8.68)**	**<.001**	**3.26 (1.39-7.66)**	**.007**

CEA, Carotid endarterectomy; *CI*, confidence interval; *MI*, myocardial infarction; *OR*, odds ratio; *TCAR*, transcarotid artery revascularization; *TFCAS*, transfemoral carotid artery stenting.
Bold values indicate statistically significant variable associations ($P < .05$).
[a]Reported in the above Table, are primary outcome univariate analyses as well as ORs with accompanying 95% CIs from logistic regression models that have been adjusted for ethnicity, race, gender, age, symptomatic status, American Society of Anesthesiologists classification, hypertension, diabetes, anesthesia type, statin use, and glomular filtration rate.

status, American Society of Anesthesiologists classification, hypertension, diabetes, anesthesia type, statin use, and glomular filtration rate. We performed a secondary multivariate analysis to compare outcomes between the three revascularization methods for weekend interventions.

Results: A total of 155,962 carotid procedures were analyzed including 103,790 (66.5%) CEA, 31,666 (20.3%) TCAR, and 20,506 (13.2%) TFCAS procedures. Of these, 1988 (1.3%) CEA, 246 (0.2%) TCAR, and 820 (0.5%) TFCAS patients received weekend interventions. Patients undergoing weekend revascularization with CEA or TFCAS had lower baseline comorbidities and were less likely to be on a statin and antiplatelet therapy. These differences were not seen in TCAR patients. Logistic regression modeling demonstrated no significant differences for TCAR procedures, and significantly increased odds of in-hospital stroke/death/myocardial infarction for CEA (odds ratio, 1.31; 95% confidence interval, 1.04-1.65) and TFCAS (odds ratio, 1.46; 95% confidence interval, 1.09-1.96) weekend procedures (Table I). Upon comparing differences in outcomes between the three revascularization methods performed on the weekend, CEA and TCAR were found to have no significant differences for all primary outcomes. Conversely, TFCAS was associated with significantly increased odds of stroke and death compared with both CEA and TCAR (Table II).

Conclusions: When compared with weekday procedures, weekend carotid revascularization is associated with higher odds of complications and mortality, particularly for patients undergoing CEA and TFCAS. Among the three revascularization methods, TFCAS is associated with the highest odds of perioperative stroke and mortality. Our findings suggest that CEA and TCAR procedures should be first-line intervention for weekend carotid revascularization. In patients who are poor candidates for CEA, TCAR offers the lowest morbidity and mortality for weekend procedures. Future prospective studies are needed to identify areas of quality improvement for weekend carotid revascularization.

Author Disclosures: C. Cui: Nothing to disclose; **J. Lane:** Nothing to disclose; **M. Malas:** Nothing to disclose; **M. Moghaddam:** Nothing to disclose; **M. Ramachandran:** Nothing to disclose; **S. Zarrintan:** Nothing to disclose.

INTERACTIVE POSTER SESSION

IP185

Outcome Comparison Between Cryopreserved Vein and Spliced Vein as Conduit for Infrageniculate Bypass

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Objectives: In the absence of autogenous vein, cryopreserved greater saphenous vein is an acceptable alternative conduit for lower extremity bypass. This study compares the outcomes of cryopreserved veins (CVs), and two-segment spliced autogenous veins (SVs) for infrageniculate lower extremity revascularization.

Methods: A retrospective review of all lower extremity infrageniculate bypass with CV or SV was conducted between 2010 and 2022. Primary outcomes included limb salvage and major adverse events. Secondary outcomes included primary, primary assisted, and secondary patency at 1 and 3 years.

Results: Sixty-three patients were included in the study, 48% (n = 30) with CV and 52% (n = 33) with SV. The groups did not significantly differ regarding demographics and comorbidities except that patients with prior coronary artery bypass grafting were more likely to have CV bypass (22.2% vs 3.23%; $P = .042$). There was no significant difference in limb loss between SV and CV at 1 (24.2% vs 33.3%; $P = .443$) and 3 years (18.2% vs 40.0%; $P = .064$). Thirty-day postoperative complications including bypass thrombosis and surgical site infection did not differ between the cohorts. Hospital readmission rates (82.2% vs 23.3%; $P \leq .001$) during the first 3 years after surgery were higher in patients undergoing CV bypass. Mortality did not differ between the two cohorts at 1 and 3 years. Primary patency at 1 (57.6% vs 33.3%; $P = .061$) and 3 years (45.2% vs 14.3%; $P = .012$) was higher in the SV group. Primary assisted patency at 1 (72.7% vs 43.3%; $P = .021$) and 3 years (54.5% vs 26.7%; $P = 0\ .029$) was also higher in the SV group. Secondary patency was higher with SV after thrombectomy or open revision at 1 (84.8% vs 50.0%; $P = .04$) and 3 (63.6% vs 30.0%; $P = 0\ .009$) years. At 3 years, 85.7% of the patients were compliant with follow-up, CV (n = 24) and SV (n = 30) groups.

Conclusions: Revascularization with a CV is an acceptable bypass alternative to an SV for patients in whom SV cannot be considered. Primary outcomes of limb salvage rates between SV and CV at 1 (75.8% vs 66.7%; $P = .443$) and 3 years (81.8% vs 60%; $P = .064$) were not statistically different. However, when comparing secondary outcomes, SV outperformed CV because patients undergoing CV had higher hospital readmission rates during the first 3 years after surgery, resulting in poor primary and secondary patency.

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INTERACTIVE POSTER SESSION

IP187

Amputation Rates and Associated Social Determinants of Health in the Most Populous US Counties

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Objectives: Social Determinants of Health (SDoH) are the environmental conditions that affect individuals' health, functional status, and quality of life, and have been demonstrated to contribute to health outcome disparities in patients with peripheral artery disease (PAD). However, the impact of specific components that comprise the SDoH are not well understood. We evaluated how the components of SDoH and related demographic factors impact amputation rates in the most populous counties of the United States (U.S.).

Methods: The Healthcare Cost and Utilization Project (HCUP) State Inpatient Database (SID) was used to determine the rates of discharge following lower extremity amputation for circulatory system disorders across the 100 largest counties of the U.S. in 2017. County demographic, hospital and SDoH data were matched using the U.S. Census, Dartmouth Atlas of HealthCare, and University of Wisconsin Population Health Institute County Health Rankings & Roadmaps data sources. Counties were divided into quartiles (Qs) based on amputation rates, and linear regression analysis was performed to assess associations between county-level amputation rates and SDoH factors.

Results: Amputation rates in the most populous U.S. counties assessed in the study varied widely from an average of 5.5 per 100,000 in Q1 to 15 per 100,000 in Q4. Compared with Q1, counties in Q4 had a higher proportion of African Americans (27% vs 7.9%; $P < .05$), diabetics (11% vs 7.9%; $P < .05$), smokers (17% vs 13%; $P < .05$), higher rates of unemployment (5.8% vs 4.6%; $P = .01$), poverty (16% vs 10%; $P < .05$), food insecurity (17% vs 13%; $P < .05$), single-parent households (42% vs 29%; $P < .05$), and physical inactivity (21% vs 17%; $P < .05$) (Table I). A significant association was found between amputation rate and county diabetes mellitus prevalence (ß = 0.68; 95% confidence interval [CI], 1.3-2.1; $P < .05$), mental distress (ß = 5.3; 95% CI, 3.7-6.9; $P < .05$), adult smokers (ß = 0.69; 95% CI, 0.46-0.92; $P < .05$), poverty (ß = 0.46; 95% CI, 0.32-0.60; $P < .05$), unemployment (ß = 1.2; 95% CI, 0.59-1.73; $P < .05$), homicide rate (ß = 0.61; 95% CI, 0.45-0.77; $P < .05$), physical inactivity (ß = 0.74; 95% CI, 0.57-0.90; $P < .05$), and food insecurity (ß = 0.51; 95% CI, 0.30-0.72; $P < .05$) (Table II).

Conclusions: Amputation rates in the most populous U.S. counties are associated with several population characteristics and components of

Table I. Patient characteristics by amputation quartile (*Q*)

	1Q	2Q	3Q	4Q	*P* value
Amputation rate per 100,000					
Average	5.5	7.9	10.4	15	<.05
Demographic data					
Age 65 and over	13	14	13	14	.16
African American	7.9	12.0	14	27	**<.05**
Asian	12.6	11.4	6.0	4.4	**<.05**
Hispanic	25	20	31	20	.20
Non-Hispanic White	51	53	47	47	.54
Uninsured	13	12	15	16	.13
Diabetic	7.9	8.9	9.4	11	**<.05**
Current smokers	13	13	15	17	**<.05**
Physical inactivity	17	20	21	21	**<.05**
Rural	2.9	3.0	3.2	3.6	.91
Unemployed	4.6	5.2	5.7	5.8	**.01**
Poverty rate	10	11	15	16	**<.05**
Single-parent household	29	28	37	42	**<.05**
Housing insecurity	21	20	22	21	.73
Food insecurity	13	13	15	17	**<.05**
High school graduate	81	85	81	79	.12
Some college	71	70	64	63	**<.05**
Not proficient in English	6.7	5.7	8.1	5.3	.15

Data are presented as percentages.
Boldface *P* values indicate statistical significance.
Quartiles corresponding to amputation rate per 100,000 in 76 US counties. 1Q (lowest amputation rate) to 4Q (highest amputation rate). Percentages reported correspondent to county averages.