Valvular Heart Disease

Machine learning analysis including social determinants of health for predication of mortality following transcatheter aortic valve implantation: a single center experience

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Introduction: Social determinants of health (SDOH) are increasingly being recognized as critical, independent prognosticators in cardiovascular disease. Despite this, little is known about the role of SDOH in predicting outcomes following transcatheter aortic valve implantation (TAVI).

Purpose: To assess the value of adding census-derived SDOH in developing machine learning (ML) models for prediction of all-cause mortality in patients following TAVI.

Methods: A total of 398 patients, who underwent TAVI in 2019, were studied. Clinical, demographic, echocardiographic (echo) and census-derived SDOH data were collected. All-cause mortality at 1 year was the endpoint. A general linear ML model was fit with 100 iterations and a 70:30 training-test split. We compared the predictive performance of the model with and without adding SDOH. The SDOH included in the ML model were race (white vs. non-white), % zip code population as female, and zip code average yearly income less than $45,000.

Results: Baseline SDOH, demographic, clinical, and echo data are shown in Table 1. Following univariate and multivariate predictor analysis, the following input data were used for the ML model without the SDOH: post TAVI all-cause hospitalizations, history of outpatient hemodialysis, atrial fibrillation, heart failure with reduced ejection fraction, myocardial infarction, coronary artery disease and beta-blockers. The ML model with SDOH used the same input as well as the SDOH variables. The model with vs. without SDOH had a median AUC of 0.75 vs. 0.73 (p = 0.9957).

Conclusions: Despite not reaching statistical significance, our ML model provides a holistic picture of mortality predictors. Larger studies are needed to more assess the predictive value of SDOH post TAVI.

Abstract Figure. Baseline patient characteristics

Table 1. Baseline SDOH, clinical, and echo characteristics.

Characteristics	All (N = 398)	Alive (N = 344)	Deceased (non-cardiac, N= 54)	P value
Demographics				
Age	77.37 (±9.6)	77.38 (±9.6)	77.34 (±9.8)	0.976
Gender (female, %)	185 (46)	164 (48)	21 (39)	0.244
Race (white, %)	338 (85)	298 (87)	40 (74)	0.037
Primary language (English, %)	156 (39)	140 (41)	16 (30)	0.135
Zip-Code aggregated Census data				
% Population Female	51.96 (±2.8)	51.76 (±2.7)	53.27 (±2.6)	<0.001
% Population White	70.93 (±23.2)	71.61 (±23.1)	66.64 (±23.7)	0.156
Average Income <45K USD/year (%)	33 (8)	25 (7)	8 (15)	0.105
% Population with High School Degree <85%	46	47	43	0.56
% Poverty	17.17 (8.2)	16.95 (8.0)	18.60 (9.4)	0.227
% Employed	52.65 (7.6)	52.75 (7.6)	51.98 (7.6)	0.49
Comorbidities				
HFrEF (%)	105 (26)	83 (24)	22 (41)	0.013
CAD (%)	276 (69)	232 (67)	44 (81)	0.039
AF/AFL (%)	142 (36)	114 (33)	28 (52)	0.009
Prior MI (%)	48 (12)	36 (10)	12 (22)	0.023
DM on insulin (%)	78 (20)	66 (19)	12 (22)	0.583
Hypertension (%)	348 (87)	297 (86)	51 (94)	0.121
Dyslipidemia (%)	330 (83)	281 (82)	49 (91)	0.12
ESRD on dialysis (%)	24 (6)	15 (4)	9 (17)	0.002
Smoker (%)	33 (8)	27 (8)	6 (11)	0.425
On beta blockers (%)	232 (58)	191 (56)	41 (76)	0.005
Echocardiographic				
LVEDD (cm)	4.87 (0.8)	4.86 (0.8)	4.93 (0.8)	0.641
LVESD (cm)	3.31 (0.8)	3.29 (0.8)	3.42 (0.9)	0.437
LVEF (%)	54.41 (12.4)	54.60 (12.0)	53.34 (14.3)	0.596
LA dilation				
Mild	59 (15)	51 (15)	8 (15)	0.408
Moderate	41 (11)	36 (10)	5 (9)	
Severe	51 (13)	40 (12)	11 (20)	
RV dilation				
Mild	32 (8)	29 (8)	3 (5)	0.339
Moderate	14 (4)	10 (3)	4 (7)	
Severe	5 (1)	4 (1)	1 (2)	
RV Function				
Normal	201 (51)	175 (51)	26 (48)	
Mildly reduced	23 (5)	20 (6)	3 (6)	0.041
Moderately reduced	18 (4)	14 (4)	4 (7)	
Severely reduced	8 (2)	4 (1)	4 (7)	
Severe MR (%)	18 (5)	14 (4)	4 (7)	0.497
Severe TR	12 (3)	8 (2)	4 (7)	0.09
AV Vmax (m/sec)	4.04 (0.8)	4.07 (0.8)	3.87 (0.8)	0.149
Mean AV PG (mmHG)	40.73 (14.9)	41.32 (14.9)	37.35 (14.2)	0.103
AV area (cm^2)	0.82 (0.3)	0.82 (0.3)	0.81 (0.3)	0.841

ACEi: ACE inhibitor, Ao: Aortic, AV: Aortic Valve, AF: atrial fibrillation, AFL: atrial flutter, CAD: coronary artery disease, DM: diabetes mellitus, ESRD: end-stage renal disease, HFrEF: heart failure with reduced ejection fraction, LA: left atrium, LVEF: left ventricular ejection fraction, LVEDD: left ventricular end-diastolic dimension, LVESD: left ventricular end-systolic dimension, MI: myocardial infarction, MR: mitral regurgitation, PG: pressure gradient, RV: right ventricle, TR: tricuspid regurgitation

Abstract Figure. ML Model: Area Under Curve

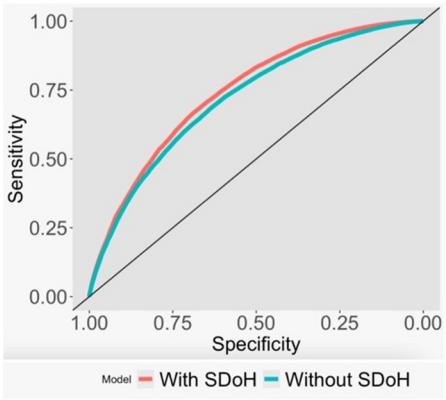

Figure 1. The AUC for the ML model with vs. without addition of SDOH. Median AUC for model with was 0.75 (sensitivity 0.8, specificity 0.66, accuracy 0.68). Median AUC for the model without was 0.73 (sensitivity 0.67, specificity 0.76, accuracy 0.75). *P* = 0.9957.