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## Predictors and Risk-Adjusted Outcomes of New-Onset Postoperative Atrial Fibrillation in Surgical and Transcatheter Aortic Valve Replacement [post-AF rAVR PROTOCOL]

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## Authors

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**Title:** Predictors and Risk-Adjusted Outcomes of New-Onset Postoperative Atrial Fibrillation in Surgical and Transcatheter Aortic Valve Replacement

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**Purpose and Specific Aims:**

This study will evaluate data in the Statewide Planning and Research Cooperative System (SPARCS) from patients without pre-existing or diagnosis of atrial fibrillation in the two-years prior to their repeat SAVR and TAVR. New York State hospital admissions for aortic valve disease from 2005-2018 will be identified for this study and will include:

- a. Patients who received repeat AVR procedures (r-AVR), specifically redo SAVR (r-SAVR) or valve-in-valve TAVR (ViV TAVR) identified from patients who received first-time surgical AVR (SAVR) or transcatheter AVR (TAVR)
  - a. Patients with confounding conditions such as age <18, emergent admissions, aortic dissection, endocarditis, thoracic aortic aneurysm, solid or metastatic cancer, and/or concurrent or 2-year prior coronary artery bypass graft or percutaneous coronary intervention procedures will be excluded.
  - b. Patients will be stratified based on presence or absence of new-onset postoperative atrial fibrillation (POAF). These will be patients who cannot have had any prior diagnosis for atrial fibrillation/flutter or prior arrhythmia intervention (e.g., Maze procedure) for 2 years pre-r-AVR procedure.

This study will identify the predictors of new-onset POAF in these patients and the impact of new-onset POAF on patient outcomes.

The following hypotheses will be tested:

H0<sub>1</sub>: There is no difference in pre-existing comorbidities for patients receiving r-SAVR versus ViV TAVR comparing between patients with and without POAF.

H0<sub>2</sub>: There is no difference in risk-adjusted outcomes for patients following r-SAVR versus ViV TAVR comparing between patients with and without POAF.

**Population:** New onset POAF atrial fibrillation patients followed from 2005-2018; r-AVR patients cannot have had any prior diagnosis for atrial fibrillation/flutter or prior arrhythmia intervention (e.g., Maze procedure) for 2 years pre-r-AVR procedure.

**Intervention:** r-SAVR versus ViV-TAVR

**Comparison:** Patients developing new onset of atrial fibrillation post-r-AVR intervention as compared to patients without any atrial fibrillation complication post-r-AVR.

**Clinical Outcomes:**

1. STS morbidity and mortality
2. STS 30-day readmission

**Sudy Design:** Retrospective Observational Cohort Study

### **Background and Significance:**

Although both surgical (SAVR) and transcatheter aortic valve replacement (TAVR) are effective treatments for aortic stenosis<sup>1</sup>, new-onset postoperative atrial fibrillation (POAF) is a common post-procedural complication that has been associated with worse mortality, increased risk of stroke, and increased hospital resource utilization compared to patients in sinus rhythm<sup>2</sup> and patients with pre-existing atrial fibrillation.<sup>3-7</sup> The prevalence of new-onset POAF varies and has been shown to be more common in patients after SAVR (35.5%-60%) than patients after TAVR (10.4%-50.4%).<sup>4,5,8-13</sup> POAF is not often a transient condition and has been shown to be an independent predictor of recurrent AF up to 5 years after a SAVR procedure. POAF is also frequently a long-term condition that requires life-long anticoagulation to prevent stroke and long-term antiarrhythmic drugs to maintain sinus rhythm or rate-control. These therapies are not without risks as life-long anticoagulation use can increase the risk of major bleeding.<sup>14</sup> Due to the increased risk of mortality and burden of disease from POAF, it is crucial to identify predictors of POAF in patients undergoing TAVR and SAVR to provide appropriate anticoagulation and consider prophylactic ablation therapy.<sup>15,16</sup> However, little is known on the predictors and impact of POAF in patients undergoing r-AVR procedures, who may be at greater risk of adverse outcomes due to repeat procedures. One single-center study has shown POAF to be present in 63.6% of 22 patients undergoing r-SAVR and 18.2% of 22 patients undergoing ViV TAVR.<sup>17</sup> More studies are needed on the incidence, predictors, and risk-adjusted outcomes of new-onset POAF in patients with r-SAVR and ViV-TAVR to provide safe and effective treatments for these patients and improve outcomes.

### **Research Design and Methods:**

This study will follow a retrospective observational cohort design and will be conducted using the SPARCS Health Facts dataset which is deidentified and publicly available. Working with Stony Brook University School of Medicine Bioinformatics Department and Biostatistics Core Lab, patients in the SPARCS database will be identified for the study according to the ICD 9/10 and CPT codes listed below. The Bioinformatic Department and Biostatistics Core Lab will also provide descriptive statistics and hypothesis testing on demographics, comorbidities and

outcomes. All statistical analyses will be performed through SAS version 9.4 and statistical significance will be determined at a p-value of  $\leq 0.05$ . All secondary and tertiary analyses, will use a p-value of  $<0.01$ .

**Please note, the SPARCS database will be de-identified. As noted on the SPARCS web site, “Public use data files contain de-identified data consisting of basic record-level detail. Public use files do not contain protected health information (PHI) under HIPAA.”**

## Sample Tables:

Sample Table 1: Baseline characteristics and risk factors in patients with and without post-operative AF/AFL (POAF/POAFL) undergoing r-SAVR and viv-TAVR

r-SAVR				viv-TAVR			
Total (N=)	POAF/POA FL (N= , %)	No POAF/POA FL (N= , %)	P-value	Total (N=)	POAF/AFL (N= , %)	No POAF/POA FL (N= , %)	P-value
Patient Characteristics							
Admission Type							
Elective							
Urgent							
Gender							
Female							
Male							
Age (years)							
Race							
Black							
Other							
Ethnicity							
Hispanic							
Other/Unknown							
Insurance							
Commercial							
Medicaid/Other							
Medicare							
Risk Factors							
Tobacco/smoking							
Obesity							
Hypertension							
CHF							
Cardiomyopathy							
Diabetes Mellitus							
CAD							
COPD							
Stroke							
Carotid Stenosis							
Cerebrovascular Disease							

Peripheral Vascular  
 Disease  
 MI  
 PPM/ICD  
 Depression  
 Bipolar Disorder  
 Schizophrenia  
 Dementia  
 Bicuspid Aortic  
 Valve  
 Syncope  
 Dyspnea  
 Chest Pain  
 Hyperlipidemia  
 Elevated Lipoprotein  
 History of Mitral  
 Valve Repair or  
 Replacement  
 AAA  
 Non-Rheumatic  
 Aortic Stenosis  
 Rheumatic Heart  
 Disease  
 Obstructive Sleep  
 Apnea  
 Leukemia  
 Lymphoma  
 CKD with dialysis  
 CKD without dialysis  
 Iron Deficiency  
 Anemia  
 Rheumatoid  
 Arthritis/Collagen  
 Vascular Diseases  
 Fluid and Electrolyte  
 Disorders  
 Pulmonary  
 Hypertension  
 Thrombocytopenia  
 Hypothyroidism  
 IABP  
 Elixhauser Mortality  
 Index  
 Elixhauser  
 Readmission Index

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R-SAVR=redo surgical aortic valve replacement, viv-TAVR=valve-in-valve transcatheter aortic valve replacement, AF/AFL=atrial fibrillation/flutter, CHF=congestive heart failure, CAD=coronary artery disease, COPD=chronic obstructive pulmonary disease, MI=myocardial infarction, PPM=permanent pacemaker, ICD=implantable cardiac defibrillator, AAA=abdominal aortic aneurysm, CKD=chronic kidney disease, IABP=intra-aortic balloon pump.

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Sample Table 2: Outcomes of r-SAVR and viv-TAVR in patients with and without post-operative AF/AFL

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r-SAVR

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viv-TAVR

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	Total (N=)	POAF/POA FL (N= , %)	No POAF/POA FL (N= , %)	P-value	Total (N=)	POAF/POA FL (N= , %)	No POAF/POA FL (N= , %)	P-value
Permanent Stroke								
Renal Failure								
DSWI								
Prolonged Ventilation								
Repeat Procedure								
Major Complication								
30-day Operative Mortality								
Composite Endpoint								
In-Hospital Death								
LOS								
Post-Operative Days								
Conversion to SAVR								
30-Day Readmission								
AKI								
Cardiac Arrest								
Major Bleeding								
Prosthetic Valve								
Endocarditis								
TIA								
Vascular								
Complications								
MI								
Major Stroke								
R-SAVR=redo surgical aortic valve replacement, viv-TAVR=valve-in-valve transcatheter aortic valve replacement, AF/AFL=atrial fibrillation/flutter, DSWI=deep sternal wound infection, LOS=length of stay, AKI=acute kidney injury, TIA=transient ischemic attack, MI=myocardial infarction.								

Sample Table 3: Univariate analysis for 30-day readmission among r-AVR patients

		Row percentage			Column percentage		
Variable	Level	Total (N=)	Yes (N=)	No (N=)	Yes (N=)	No (N=)	P-value*
Primary factors							
Post-operative AF/AFL	No						
	Yes						
Surgery type	Redo SAVR						
	ViV TAVR						
Type of admission	Elective						
	Urgent						
Patients' characteristics							
Gender	Female						
	Male						
Age	Unit=year						

Variable	Level	Total (N=)	Row percentage		Column percentage		P-value*
			Yes (N=)	No (N=)	Yes (N=)	No (N=)	
Race	Black						
	Other						
Ethnicity	Hispanic						
	Other\unknown						
Insurance	Commercial						
	Medicaid\Other						
	Medicare						
Risk factors							
Tobacco/Smoking	No						
	Yes						
Hypertension	No						
	Yes						
CHF	No						
	Yes						
Cardiomyopathy	No						
	Yes						
Diabetes mellitus	No						
	Yes						
CAD	No						
	Yes						
COPD	No						
	Yes						
Stroke	No						
	Yes						
Carotid stenosis	No						
	Yes						
Cerebrovascular Disease	No						
	Yes						
Peripheral Vascular Disease	No						
	Yes						
MI	No						
	Yes						
PPM/ICD	No						
	Yes						



Variable	Level	Row percentage			Column percentage		P-value*
		Total (N=)	Yes (N=)	No (N=)	Yes (N=)	No (N=)	
Depression	No						
	Yes						
Bipolar Disorder	No						
	Yes						
Schizophrenia	No						
	Yes						
Dementia	No						
	Yes						
Bicuspid Aortic Valve	No						
	Yes						
Syncope	No						
	Yes						
Dyspnea	No						
	Yes						
Chest Pain	No						
	Yes						
Dialysis	No						
	Yes						
Hyperlipidemia	No						
	Yes						
Elevated Lipoprotein	No						
	Yes						
History of Mitral Valve Repair or Replacement	No						
	Yes						
AAA	No						
	Yes						
Non rheumatic aortic stenosis	No						
	Yes						
Rheumatic Heart Disease	No						
	Yes						
Obstructive Sleep Apnea	No						
	Yes						
Leukemia	No						
	Yes						
Lymphoma	No						

Variable	Level	Row percentage		Column percentage		P-value*
		Total (N=)	Yes (N=)	No (N=)	Yes (N=)	No (N=)
CKD, with dialysis	Yes					
	No					
CKD, without dialysis	Yes					
	No					
Obesity	Yes					
	No					
Iron Deficiency Anemia	Yes					
	No					
Rheumatoid arthritis/collagen vascular diseases	Yes					
	No					
Fluid and Electrolyte Disorders	Yes					
	No					
Pulmonary Hypertension	Yes					
	No					
Thrombocytopenia	Yes					
	No					
Hypothyroidism	Yes					
	No					
IABP	Yes					
	No					
Elixhauser Readmission Index						

Note: For continuous variable, mean+/-std were reported.

\*: For categorical variables, p-values were based on Chi-squared test with exact p-value from Monte Carlo simulation; for continuous variables, p-value was based on Welch's t-test.

R-SAVR=redo surgical aortic valve replacement, viv-TAVR=valve-in-valve transcatheter aortic valve replacement, AF/AFL=atrial fibrillation/flutter, CHF=congestive heart failure, CAD=coronary artery disease, COPD=chronic obstructive pulmonary disease, MI=myocardial infarction, PPM=permanent pacemaker, ICD=implantable cardiac defibrillator, AAA=abdominal aortic aneurysm, CKD=chronic kidney disease, IABP=intra-aortic balloon pump

Sample Table 4: Univariate analysis for composite endpoint among r-AVR patients

		Row percentage			Column percentage		
Variable	Level	Total (N=)	Yes (N=)	No (N=)	Yes (N=)	No (N=)	P-value*
Primary factors							
Post-operative AF/AFL	No						
	Yes						
Surgery type	Redo SAVR						
	ViV TAVR						
Type of admission	Elective						
	Urgent						
Patients' characteristics							
Gender	Female						
	Male						
Age	Unit=year						
Race	Black						
	Other						
Ethnicity	Hispanic						
	Other\unknown						
Insurance	Commercial						
	Medicaid\Other						
	Medicare						
Risk factors							
Tobacco/Smoking	No						
	Yes						
Hypertension	No						
	Yes						
CHF	No						
	Yes						
Cardiomyopathy	No						
	Yes						
Diabetes mellitus	No						
	Yes						
CAD	No						
	Yes						
COPD	No						
	Yes						
Stroke	No						

Variable	Level	Row percentage			Column percentage		P-value*
		Total (N=)	Yes (N=)	No (N=)	Yes (N=)	No (N=)	
Carotid stenosis	Yes						
	No						
Cerebrovascular Disease	Yes						
	No						
Peripheral Vascular Disease	Yes						
	No						
MI	Yes						
	No						
PPM/ICD	Yes						
	No						
Depression	Yes						
	No						
Bipolar Disorder	Yes						
	No						
Schizophrenia	Yes						
	No						
Dementia	Yes						
	No						
Bicuspid Aortic Valve	Yes						
	No						
Syncope	Yes						
	No						
Dyspnea	Yes						
	No						
Chest Pain	Yes						
	No						
Dialysis	Yes						
	No						
Hyperlipidemia	Yes						
	No						
Elevated Lipoprotein	Yes						
	No						
History of Mitral Valve Repair or Replacement	Yes						
	No						

Variable	Level	Row percentage			Column percentage		P-value*
		Total (N=)	Yes (N=)	No (N=)	Yes (N=)	No (N=)	
AAA	No						
	Yes						
Non rheumatic aortic stenosis	No						
	Yes						
Rheumatic Heart Disease	No						
	Yes						
Obstructive Sleep Apnea	No						
	Yes						
Leukemia	No						
	Yes						
Lymphoma	No						
	Yes						
CKD, with dialysis	No						
	Yes						
CKD, without dialysis	No						
	Yes						
Obesity	No						
	Yes						
Iron Deficiency Anemia	No						
	Yes						
Rheumatoid arthritis/collagen vascular diseases	No						
	Yes						
Fluid and Electrolyte Disorders	No						
	Yes						
Pulmonary Hypertension	No						
	Yes						
Thrombocytopenia	No						
	Yes						
Hypothyroidism	No						
	Yes						
IABP	No						
	Yes						
Elixhauser Readmission Index							

Variable	Level	Total (N=)	Row percentage		Column percentage		P-value*
			Yes (N=)	No (N=)	Yes (N=)	No (N=)	

Note: For continuous variable, mean+/-std were reported.  
\*: For categorical variables, p-values were based on Chi-squared test with exact p-value from Monte Carlo simulation;  
for continuous variables, p-value was based on Welch's t-test.  
R-SAVR=redo surgical aortic valve replacement, viv-TAVR=valve-in-valve transcatheter aortic valve replacement, AF/AFL=atrial fibrillation/flutter, CHF=congestive heart failure, CAD=coronary artery disease, COPD=chronic obstructive pulmonary disease, MI=myocardial infarction, PPM=permanent pacemaker, ICD=implantable cardiac defibrillator, AAA=abdominal aortic aneurysm, CKD=chronic kidney disease, IABP=intra-aortic balloon pump

Sample Table 5: Multivariable Model Findings for 30-Day Readmission

	Odds Ratio	95% Confidence Interval	P-value
Post-operative AF/AFL			
Variable 1			
Variable 2			
Variable 3			
Model C-index =			

Sample Table 6: Multivariable Model Findings for STS MM Composite Endpoint

	Odds Ratio	95% Confidence Interval	P-value
Post-operative AF/AFL			
Variable 1			
Variable 2			
Variable 3			
Model C-index =			

Sample Table 7: Risk Factor and Outcome ICD Billing Codes

Risk factors	ICD-10	ICD-9	CPT Codes
*: all specific codes under the general codes were used.			
Intra-aortic Balloon Pump	5A02210	37.61	

Tobacco/Smoking	Z72.0, F17.21-F17.299, Z87.891	V15.82, 305.1	
Hypertension	I10, I11.0, I11.9, I12.0, I12.9, I13.0, I13.1, I13.10, I13.11, I13.2, I15, I15.0, I15.1, I15.2, I15.8, I15.9, I16, I16.0, I16.1, I16.9	401.0, 401.1, 401.9, 402.01, 402.11, 402.91, 402.00, 402.10, 402.90, 403.01, 403.11, 403.91, 403.00, 403.10, 403.90, 404.01, 404.11, 404.91, 404.00, 404.10, 404.90, 404.02, 404.12, 404.92, 404.03, 404.13, 404.93, 405.01, 405.11, 405.19, 405.91, 405.99, 405.09, 405.19, 405.99	
Congestive Heart Failure	I09.9, I11.0, I13.0, I13.2, I25.5, I42.0, I42.5-I42.9, I43, P29.0. *: I50.	398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 414.8, 425.4-425.99. *: 428.	
Cardiomyopathy	I25.5, I42.0, I42.5-I42.9, I43	*: 425	
Diabetes Mellitus	*: E08, E09, E10, E11, E13.	*: 249, 250.	
Coronary Artery Disease	*: I25.1, I25.2, I25.3, I25.4, I25.6, I25.7, I25.8, I25.9.	*: 414	
Chronic Lung Disease	*: J41, J42, J43, J44, J45, J47.	*: 491, 492, 493, 494, 496.	
Chronic Obstructive Pulmonary Disease (COPD)	*: J41, J42, J43, J44  - Asthma and Bronchiectasis were not counted as a chronic obstructive pulmonary disease	*: 491, 492, 496.  - Asthma and Bronchiectasis were not counted as a chronic obstructive pulmonary disease	
History of Stroke	Z86.73	V12.54	

Stroke	Z86.73, G45.8, G45.9. *: I63.	V12.54, 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, 435.2, 435.9, 435.8	
Carotid Disease	I65.21, I65.22, I65.23, I65.29, I77.71, G45.1	433.0-433.3, 435.8, 443.21	
Carotid Stenosis	*: I65.2;	*: 433.1;	
Cerebral Vascular Disease	Z86.73. *: I60, I61, I62, I63, I65, I66, I67, I68, I69, G45, G46.	V12.54. *: 430, 431, 432, 433, 434, 435, 436, 437, 438.	
Peripheral Vascular Disease	I73.00, I73.01, I73.1, I73.81, I73.89, I73.9, I70.20-I70.25, I70.8, I70.92	443.0, 443.1, 443.21, 443.22, 443.23, 443.24, 443.29, 443.81, 443.82, 443.89, 443.9	
Atrial Fibrillation/Atrial Flutter	I48-I48.4, I48.9-I48.92	427.3-427.32	
Myocardial Infarction (MI)	I25.2. *: I21, I22.	412. *: 410	
Prior MI Documented	I25.2.	412.	
Prior Coronary Artery Bypass Graft	Z95.1, Z95.5.	V45.81.	
Prior Percutaneous Coronary Intervention	Z98.61.	V45.82.	
Permanent Pacemaker or Implantable Cardiac Defibrillator (PPM/ICD)	Z95.0, Z95.810.	V45.01, V45.02.	



Depression	*: F32, F33	298.0, 296.82, 311, 298.0, 296.20-296.36	
Bipolar Disorder	*: F31.	296.40, 296.41, 296.42, 296.43, 296.44, 296.50-296.54, 296.60-296.64, 296.7, 296.45, 296.46, 296.55, 296.56, 296.65, 296.66, 296.89, 296.40, 296.80	
Schizophrenia	*: F20.	*: 295.	
Dementia	F01.50, F01.51, F02.80, F02.81, F03.90, F03.91, G31.01, G31.09, G31.83.	290.0, 290.10, 290.11, 290.13, 290.21, 290.40, 290.41, 290.8, 290.9, 294.10, 294.11, 294.20, 294.21, 331.11, 331.19, 331.82.	
Bicuspid Aortic Valve	Q23.1.	746.4.	
Syncope	R55, G90.01.	780.2, 337.01.	
Dyspnea	R06.00, R06.01, R06.02, R06.03, R06.09.	518.82, 786.02, 786.05, 786.09, 770.89.	
Chest Pain	*: I20.	413.1, 413.9, 411.1	
Dialysis	Z99.2.	V45.11.	
Hyperlipidemia	E78.00, E78.01, E78.1, E78.2, E78.3, E78.49, E78.5.	272.0, 272.1, 272.2, 272.3, 272.4.	
Elevated Lipoprotein	E78.41	.	

History of Mitral Valve Repair or Replacement	Z95.2- Z95.4	V42.2, V43.3	
History of Aortic Valve replacement	Z95.2- Z95.4	V42.2, V43.3	
Presence of Prosthetic Heart valve	Z95.2-Z95.4	V42.2	
Abdominal Aortic Aneurysm	I71.3, I71.4, Z86.79	441.3, 441.4, V12.59	
Aortic Valve Disorders	I06.0, I06.1, I06.2, I08.0, I08.2, I08.3, I35.0, I35.1, I35.2, I35.8, I35.9	395.0, 395.2, 396.1, 396.3, 424.1	
Non rheumatic aortic stenosis	I35.0, I35.2	424.1	
Rheumatic Heart Disease	I05.0-I09.9	393, 394.1, 395.0-395.9 397.1-397.9, 398.90-398.99	
Obstructive Sleep Apnea	G47.33	327.23	
BMI	< 19.9: Z68.1 20-29: Z68.20-Z68.29 30-39: Z68.30-Z68.39 >40.0: Z68.41-Z68.45	< 19: V85.0 19-24: V85.1 25.0-29.9: V85.21-V85.25 30.0-39.9: V85.30-V85.39 >40.0: V85.41-V85.44	
Leukemia	*: C91, C92, C93, C94, C95.	*: 204, 205, 206, 207, 208.	

Lymphoma	C81.00-C81.99, C82.00-C82.99, C83.00-C83.99, C84.00-C84.99, C85.10-C85.99, C86.0-C85.6, C88.4	200.20-200.78, 201.00-201.98, 202.00-202.08, 202.20-202.28, 202.70-202.98	
Chronic kidney disease (CKD) Stage I Stage II Stage III Stage IV Stage V ESRD	N18.1 N18.2 N18.3 N18.4 N18.5 N18.6	585.1 585.2 585.3 585.4 585.5 585.6	
CKD, with dialysis	Z99.2	V45.11	
CKD, without dialysis	N18.1-N18.9	585.1-585.9	
Thoracic Aortic Aneurysm without rupture	I71.2	441.2	
Thoracic aortic aneurysm, ruptured	I71.1	441.1	
Obesity	E66-E66.9	278-278.3	
Anemia of Deficiency, iron deficiency	D64.9	280.1-281.9, 285.21-285.29, 285.9	
Collagen Vascular Disease	M35.1	701.0, 710.0-710.9, 714.0-714.9, 720.0-720.9, 725	

Fluid and Electrolyte Disorders	E87.0	*:276.	
Pulmonary Hypertension	I27.0, I27.2-I27.299	416, 416.8	
Platelet count (thrombocytopenia)	*: D69.1, D69.3, D69.4, D69.5, D69.6.	*: 287.1, 287.3, 287.4, 287.5.	
Previous internal cardioverter-defibrillator	Z95.810	V45.02	
Cerebral occlusion	*: I66	*: 434.	
Hypothyroidism	E00.0-E00.9, E01.0-E01.8, E02, E03.0-E0.39	243, 244-244.9	
Thrombocytopenia	D69.1, D69.3, D69.4-D69.6	287.1, 287.3-287.5	
<b>Procedures</b>			
SAVR	02RF07Z, 02RF0JZ, 02RF08Z, 02RF0KZ	35.21, 35.22	33405, 33406, 33410
TAVR - Non-femoral Access	02RF37H, 02RF38H, 02RF3JH, 02RF3KH	35.06	33363, 33364, 33365, 33366, 33369
TAVR - Femoral Access	02RF37Z, 02RF38Z, 02RF3JZ, 02RF3KZ, 02RF47Z, 02RF48Z, 02RF4JZ, 02RF4KZ	35.05	33361, 33362, 33367, 33368

STS Outcomes			
Permanent Stroke (diagnosis)	I97.810, I97.811, I97.820, I97.821	997.02	
Renal Failure (diagnosis)	N17.0-N17.9, N99.0, Z49.01-Z49.02, Z99.2.	584.5, 584.6, 584.7, 584.8, 584.9, 997.5, V45.11, V56.1-V56.2.	
Prolonged Ventilation (diagnosis)	5A1945Z, 5A1955Z	96.72	
Reoperation For Any Cardiac Reason  Reoperation for bleeding/tamponade (diagnosis)  Valvular dysfunction (diagnosis)  Unplanned coronary artery intervention (procedure)  Aortic reintervention (diagnosis or procedure)	I97.610, I97.611, I97.618, I97.51.  T82.01XA, T82.02XA, T82.03XA, T82.09XA.  *: 0210, 0211, 0212, 0213, 0270, 0271, 0272, 0273.  Diagnosis: Z95.2-Z95.4.  Procedure: 02RF07Z, 02RF0JZ, 02RF08Z, 02RF0KZ, 02RF37H, 02RF38H, 02RF3JH, 02RF3KH, 02RF37Z, 02RF38Z, 02RF3JZ, 02RF3KZ, 02RF47Z, 02RF48Z, 02RF4JZ, 02RF4KZ, 02RX07Z, 02RX08Z, 02RX0JZ, 02RX0KZ, 02RW07Z, 02RW08Z, 02RW0JZ, 02RW0KZ, 02UW07Z, 02UW08Z, 02UW0JZ, 02UW0KZ, 02UX07Z, 02UX08Z, 02UX0JZ, 02UX0KZ, 02VW0DZ, 02VX0DZ, 02QW0ZZ, 02QX0ZZ, 02RX47Z, 02RX48Z, 02RX4JZ, 02RX4KZ, 02RW47Z, 02RW48Z, 02RW4JZ, 02RW4KZ, 02UW37Z, 02UW38Z, 02UW3JZ, 02UW3KZ, 02UW47Z, 02UW48Z, 02UW4JZ, 02UW4KZ, 02UX37Z, 02UX38Z, 02UX3JZ, 02UX3KZ, 02UX47Z, 02UX48Z, 02UX4JZ, 02UX4KZ, 02VX3DZ, 02VX4DZ, 02QX3ZZ, 02QX4ZZ, 02VW3DZ, 02VW4DZ, 02QW3ZZ, 02QW4ZZ.	998.11, 998.2.  996.02.  36.1-36.19, 36.06, 36.07, 0.66  Diagnosis: V43.3, V42.2.  Procedure: 35.21, 35.22, 35.05, 35.06, 38.35, 38.45, 39.73.	Procedure: 33405, 33406, 33410, 33361, 33362, 33363, 33364, 33365, 33366, 33367, 33368, 33369.

Other cardiac reason (diagnosis or procedure)	<p>Diagnosis: Z95.810, Z95.811.</p> <p>Procedure: 02QG0ZE, 02QG0ZZ, 02QG3ZE, 02QG3ZZ, 02QG4ZE, 02QG4ZZ, 02QH0ZZ, 02QH3ZZ, 02QH4ZZ, 02QJ0ZG, 02QJ0ZZ, 02QJ3ZG, 02QJ3ZZ, 02QJ4ZG, 02QJ4ZZ, 02RG07Z, 02RG08Z, 02RG0JZ, 02RG0KZ, 02RG37H, 02RG37Z, 02RG38H, 02RG38Z, 02RG3JH, 02RG3JZ, 02RG3KH, 02RG3KZ, 02RG47Z, 02RG48Z, 02RG4JZ, 02RG4KZ, 02RH07Z, 02RH08Z, 02RH0JZ, 02RH0KZ, 02RH37H, 02RH37Z, 02RH38H, 02RH38Z, 02RH3JH, 02RH3JZ, 02RH3KH, 02RH3KZ, 02RH47Z, 02RH48Z, 02RH4JZ, 02RH4KZ, 02RJ07Z, 02RJ08Z, 02RJ0JZ, 02RJ0KZ, 02RJ37H, 02RJ37Z, 02RJ38H, 02RJ38Z, 02RJ3JH, 02RJ3JZ, 02RJ3KH, 02RJ3KZ, 02RJ47Z, 02RJ48Z, 02RJ4JZ, 02RJ4KZ.</p>	<p>Diagnosis: V45.02, V43.21.</p> <p>Procedure: 35.99, 35.12, 35.33, 35.13, 35.33, 35.99, 35.14, 35.33, 35.23, 35.24, 35.09, 35.25, 35.26, 35.08, 35.07, 35.27, 35.28, 35.09.</p>	<p>Procedure: 0345T, 33418, 33419, 33425, 33426, 33427, 33430, 0483T, 0484T, 33463, 33464, 33465, 33475, 33470, 33471, 33472, 33473, 33474, 33440, 33411, 33412, 33413.</p>
Deep Sternal Wound Infection / Mediastinitis (diagnosis)	J98.51, J85.3, T81.42XA, T81.43XA	519.2, 519.3, 513.1	
Outcomes			
AKI	N17.0-N17.9, N99.0, Z99.2	584.5, 584.6 584.7, 584.8, 584.9, 997.5, V45.11	
Cardiac Arrest	I97.120, I97.710, I46.9	429.4, 997.1, 427.5	
Major Bleeding	I97.610, I97.611, I97.618, I97.51	998.11, 998.2	
Endocarditis	B37.6, I33.0, I33.9, A52.03, M32.11, I01.1 I38, I39, I09.1, A32.82, A39.51, B33.21, I35.8, A18.84, A54.83	391.1, 112.81, 421.0, 421.1, 421.9, 093.20-093.24, 424.91, 424.90, 397.9, 036.42, 074.22, 098.84	
TIA	G45.9	435.9	

Vascular Complications	T81718A, T81719A, T8172XA	9972, 99779	
MI	I21.0-I21.99, I21.A, I21.A1, I21.A9	410.00-410.92	
Major Stroke	I97.81-I97.821, I63-I63.9	997.02, 433.91, 433.21, 433.01, 433.11, 433.81, 433.91, 434.01, 434.11, 434.91, 433.31	

Sample Table 8: Elixhauser comorbidity scores, ICD billing codes, and variable weighting

Comorbidity	ICD-9 Codes	ICD-10 Codes	Mortality Weight	Readmission Weight
Congestive Heart Failure	39891, 4280-4289	I0981, I501, I5020, I5021, I5022, I5023, I5030, I5031, I5032, I5033, I5040, I5041, I5042, I5043, I50810, I50811, I50812, I50813, I50814, I5082, I5083, I5084, I5089, I509	9	13
Valvular Disease	09320-09324, 3940-3971, 3979, 4240-42499, 7463-7466, V422, V433	A5203, I050, I051, I052, I058, I059, I060, I061, I062, I068, I069, I070, I071, I072, I078, I079, I080, I081, I082, I083, I088, I089, I091, I0989, I340, I341, I342, I348, I349, I350, I351, I352, I358, I359, I360, I361, I362, I368, I369, I370, I371, I372, I378, I379, I38, I39, Q230, Q231, Q232, Q233, Z952, Z953, Z954	0	0
Pulmonary Circulation Disorder	4150-41519, 4160-4169, 4179, 999.1	I2601, I2602, I2609, I2690, I2692, I2693, I2694, I2699, I270, I271, I2781, I2782, I2783, I2789, I279, I289, T800XXA, T82817A, T82818A	6	5
Peripheral Vascular Disorder	4400-4409, 44100-4419, 4420- 4429, 4430-4439, 44421-44422, 449, 4471, 5571, 5579, V434	I700-I7092, I7100-I719, I720, I721-I729, I731, I7381, I7389, I739, I742, I743, I744, I76, I771, I7770, I7771, I7772, I7773, I7774, I7775, I7776, I7777, I7779, I790, I791, I798, K551, K558, K559, Z95820, Z95828	3	4
Hypertension	4011, 4019, 64200-64204, 4010, 4372, 64220-64224, 40200, 40210, 40290, 40509, 40519, 40599, 40201, 40211, 40291 40300, 40310, 40390, 40501, 40511, 40591, 64210-64214, 40301, 40311, 40391, 40400, 40410, 40490, 40401, 40411, 40491, 40402, 40412, 40492, 40403, 40413, 40493, 64270- 64274, 64290-64294	I130, I132, I1310, I1311, I129, I150, I151, I120, I10, O10011, O10012, O10013, O10019, O1002, O1003, O10911, O10912, O10913, O10919, O1092, O1093, I160, I161, I169, I674, O10111, O10112, O10113, O10119, O1012, O1013, O10211, O10212, O10213, O10219, O1022, O1023, O10311, O10312, O10313, O10319, O1032, O1033, O10411, O10412, O10413, O10419, O1042, O1043, O111, O112, O113, O114, O115, O119, I110, I119, I152, I158, I159, O161, O162, O163, O164, O165, O169	-1	-1
Paralysis	3420-3449, 43820-43853, 78072	G041, G800, G801, G802, G804, G808,	5	6

		G809, G8100, G8101, G8102, G8103, G8104, G8110, G8111, G8112, G8113, G8114, G8190, G8191, G8192, G8193, G8194, G8220, G8221, G8222, G8250, G8251, G8252, G8253, G8254, G830, G8310, G8311, G8312, G8313, G8314, G8320, G8321, G8322, G8323, G8324, G8330, G8331, G8332, G8333, G8334, G834, G835, G8381, G8382, G8383, G8384, G8389, G839, I69031, I69032, I69033, I69034, I69039, I69041, I69042, I69043, I69044, I69049, I69051, I69052, I69053, I69054, I69059, I69061, I69062, I69063, I69064, I69065, I69069, I69131, I69132, I69133, I69134, I69139, I69141, I69142, I69143, I69144, I69149, I69151, I69152, I69153, I69154, I69159, I69161, I69162, I69163, I69164, I69165, I69169, I69231, I69232, I69233, I69234, I69239, I69241, I69242, I69243, I69244, I69249, I69251, I69252, I69253, I69254, I69259, I69261, I69262, I69263, I69264, I69265, I69269, I69331, I69332, I69333, I69334, I69339, I69341, I69342, I69343, I69344, I69349, I69351, I69352, I69353, I69354, I69359, I69361, I69362, I69363, I69364, I69365, I69369, I69831, I69832, I69833, I69834, I69839, I69841, I69842, I69843, I69844, I69849, I69851, I69852, I69853, I69854, I69859, I69861, I69862, I69863, I69864, I69865, I69869, I69931, I69932, I69933, I69934, I69939, I69941, I69942, I69943, I69944, I69949, I69951, I69952, I69953, I69954, I69959, I69961, I69962, I69963, I69964, I69965, I69969, R532		
Neurodegenerative Disorders	3300-3319, 3320, 3334, 3335, 3337, 33371, 33372, 33379, 33385, 33394, 3340-3359, 3380, 340, 3411-3419, 34500-34511, 3452-3453, 34540-34591, 34700-34701, 34710-34711, 64940-64944, 7687, 76870-76873, 7803, 78031, 78032, 78033, 78039, 78097, 7843, 348.9, 348.89	E7500, E7501, E7502, E7509, E7510, E7511, E7519, E7523, E7525, E7526, E7529, E754, F842, G10, G110, G111, G112, G113, G114, G118, G119, G120, G121, G1220, G1221, G1222, G1223, G1224, G1225, G1229, G128, G129, G132, G138, G20, G214, G2401, G2402, G2409, G242, G248, G254, G255, G2581, G300, G301, G308, G309, G3101, G3109, G311, G312, G3181, G3182, G3183, G3184, G3185, G3189, G319, G3281, G35, G361, G368, G369, G370, G371, G372, G373, G374, G375, G378, G379, G40001, G40009, G40011, G40019, G40101, G40109, G40111, G40119, G40201, G40209, G40211, G40219, G40301, G40309, G40311, G40319, G40401, G40409, G40411, G40419, G40501, G40509, G40801, G40802, G40803, G40804, G40811, G40812, G40813, G40814, G40821, G40822, G40823, G40824, G4089, G40901, G40909, G40911, G40919, G40A01, G40A09, G40A11, G40A19, G40B01, G40B09, G40B11, G40B19, G47411, G47419, G47421, G47429, G803, G890, G910, G911, G912, G913, G914, G918, G919, G937, G9389, G939, G94, O99350, O99351, O99352, O99353, O99354,	5	7



		O99355, P9160, P9161, P9162, P9163, R410, R4182, R4701, R5600, R5601, R561, R569		
Chronic Pulmonary Disease	490-4941, 4950-505, 5064	J40, J410, J411, J418, J42, J430, J431, J432, J438, J439, J440, J441, J449, J4520, J4521, J4522, J4530, J4531, J4532, J4540, J4541, J4542, J4550, J4551, J4552, J45901, J45902, J45909, J45990, J45991, J45998, J470, J471, J479, J60, J61, J620, J628, J630, J631, J632, J633, J634, J635, J636, J64, J660, J661, J662, J668, J670, J671, J672, J673, J674, J675, J676, J677, J678, J679, J684,	3	8
Diabetes uncomplicated	25000-25033, 64800-64804, 24900-24931	E0800, E0801, E0810, E0811, E089, E0900, E0901, E0910, E0911, E099, E1010, E1011, E109, E1100, E1101, E1110, E1111, E119, E1300, E1301, E1310, E1311, E139, O24011, O24012, O24013, O24019, O2402, O2403, O24111, O24112, O24113, O24119, O2412, O2413, O24311, O24312, O24313, O24319, O2432, O2433, O24811, O24812, O24813, O24819, O2482, O2483, O24911, O24912, O24913, O24919, O2492, O2493	0	6
Diabetes complicated	25040-25093, 7751, 4940-24991	E0821, E0822, E0829, E08311, E08319, E08321, E083211, E083212, E083213, E083219, E08329, E083291, E083292, E083293, E083299, E08331, E083311, E083312, E083313, E083319, E08339, E083391, E083392, E083393, E083399, E08341, E083411, E083412, E083413, E083419, E08349, E083491, E083492, E083493, E083499, E08351, E083511, E083512, E083513, E083519, E083521, E083522, E083523, E083529, E083531, E083532, E083533, E083539, E083541, E083542, E083543, E083549, E083551, E083552, E083553, E083559, E08359, E083591, E083592, E083593, E083599, E0836, E0837X1, E0837X2, E0837X3, E0837X9, E0839, E0840, E0841, E0842, E0843, E0844, E0849, E0851, E0852, E0859, E08610, E08618, E08620, E08621, E08622, E08628, E08630, E08638, E08641, E08649, E0865, E0869, E088, E0921, E0922, E0929, E09311, E09319, E09321, E093211, E093212, E093213, E093219, E09329, E093291, E093292, E093293, E093299, E09331, E093311, E093312, E093313, E093319, E09339, E093391, E093392, E093393, E093399, E09341, E093411, E093412, E093413, E093419, E09349, E093491, E093492, E093493, E093499, E09351, E093511, E093512, E093513, E093519, E093521, E093522, E093523, E093529, E093531, E093532, E093533, E093539, E093541, E093542, E093543, E093549, E093551, E093552, E093553, E093559, E09359, E093591, E093592, E093593, E093599, E0936, E0937X1, E0937X2, E0937X3, E0937X9,	-3	9

		E0939, E0940, E0941, E0942, E0943, E0944, E0949, E0951, E0952, E0959, E09610, E09618, E09620, E09621, E09622, E09628, E09630, E09638, E09641, E09649, E0965, E0969, E098, E1021, E1022, E1029, E10311, E10319, E10321, E103211, E103212, E103213, E103219, E10329, E103291, E103292, E103293, E103299, E10331, E103311, E103312, E103313, E103319, E10339, E103391, E103392, E103393, E103399, E10341, E103411, E103412, E103413, E103419, E10349, E103491, E103492, E103493, E103499, E10351, E103511, E103512, E103513, E103519, E103521, E103522, E103523, E103529, E103531, E103532, E103533, E103539, E103541, E103542, E103543, E103549, E103551, E103552, E103553, E103559, E10359, E103591, E103592, E103593, E103599, E1036, E1037X1, E1037X2, E1037X3, E1037X9, E1039, E1040, E1041, E1042, E1043, E1044, E1049, E1051, E1052, E1059, E10610, E10618, E10620, E10621, E10622, E10628, E10630, E10638, E10641, E10649, E1065, E1069, E108, E1121, E1122, E1129, E11311, E11319, E11321, E113211, E113212, E113213, E113219, E11329, E113291, E113292, E113293, E113299, E11331, E113311, E113312, E113313, E113319, E11339, E113391, E113392, E113393, E113399, E11341, E113411, E113412, E113413, E113419, E11349, E113491, E113492, E113493, E113499, E11351, E113511, E113512, E113513, E113519, E113521, E113522, E113523, E113529, E113531, E113532, E113533, E113539, E113541, E113542, E113543, E113549, E113551, E113552, E113553, E113559, E11359, E113591, E113592, E113593, E113599, E1136, E1137X1, E1137X2, E1137X3, E1137X9, E1139, E1140, E1141, E1142, E1143, E1144, E1149, E1151, E1152, E1159, E11610, E11618, E11620, E11621, E11622, E11628, E11630, E11638, E11641, E11649, E1165, E1169, E118, E1321, E1322, E1329, E13311, E13319, E13321, E133211, E133212, E133213, E133219, E13329, E133291, E133292, E133293, E133299, E13331, E133311, E133312, E133313, E133319, E13339, E133391, E133392, E133393, E133399, E13341, E133411, E133412, E133413, E133419, E13349, E133491, E133492, E133493, E133499, E13351, E133511, E133512, E133513, E133519, E133521, E133522, E133523, E133529, E133531, E133532, E133533, E133539, E133541, E133542, E133543, E133549, E133551, E133552, E133553, E133559, E13359, E133591, E133592, E133593, E133599, E1336, E1337X1, E1337X2, E1337X3, E1337X9, E1339, E1340, E1341, E1342, E1343, E1344, E1349, E1351, E1352, E1359, E13610,		
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		E13618, E13620, E13621, E13622, E13628, E13630, E13638, E13641, E13649, E1365, E1369, E138, P702		
Hypothyroidism	243-2449	E000, E001, E002, E009, E018, E02, E030, E031, E032, E033, E038, E039, E890	0	0
Renal Failure	5853, 5854, 5855, 5856, 5859, 586, V420, V451, V560-V5632, V568, V4511-V4512	N183, N184, N185, N186, N189, N19, Z4901, Z4902, Z4931, Z4932, Z9115, Z940, Z992	6	15
Liver Disease	07022, 07023, 07032, 07033, 07044, 07054, 4560, 4561, 45620, 45621, 5710, 5712, 5713, 57140-57149, 5715, 5716, 5718, 5719, 5723, 5728, 5735, V427, 572.2, 5733, 573.8, 573.9	B180, B181, B182, I8500, I8501, I8510, I8511, K700, K702, K7030, K7031, K7040, K7041, K709, K7210, K7211, K7290, K7291, K730, K731, K732, K738, K739, K740, K741, K742, K743, K744, K745, K7460, K7469, K754, K7581, K760, K766, K7689, K769, Z944	4	10
Peptic Ulcer Disease, Excluding Bleeding	53141, 53151, 53161, 53170, 53171, 53191, 53241, 53251, 53261, 53270, 53271, 53291, 53341, 53351, 53361, 53370, 53371, 53391, 53441, 53451, 53461, 53470, 53471, 53491, 531.40, 531.50, 531.90, 532.40, 532.50, 532.60, 532.90, 533.40, 533.50, 533.60, 533.90, 534.40, 534.50, 534.60, 534.90	K254, K255, K256, K257, K259, K264, K265, K266, K267, K269, K274, K275, K276, K277, K279, K284, K285, K286, K287, K289	0	0
AIDS/HIV	042 -0449	B20	0	19
Lymphoma	20000-20238, 20250-2030, 2386, 2733, 20302-20382, 238.79	C8100, C8101, C8102, C8103, C8104, C8105, C8106, C8107, C8108, C8109, C8110, C8111, C8112, C8113, C8114, C8115, C8116, C8117, C8118, C8119, C8120, C8121, C8122, C8123, C8124, C8125, C8126, C8127, C8128, C8129, C8130, C8131, C8132, C8133, C8134, C8135, C8136, C8137, C8138, C8139, C8140, C8141, C8142, C8143, C8144, C8145, C8146, C8147, C8148, C8149, C8170, C8171, C8172, C8173, C8174, C8175, C8176, C8177, C8178, C8179, C8190, C8191, C8192, C8193, C8194, C8195, C8196, C8197, C8198, C8199, C8200, C8201, C8202, C8203, C8204, C8205, C8206, C8207, C8208, C8209, C8210, C8211, C8212, C8213, C8214, C8215, C8216, C8217, C8218, C8219, C8220, C8221, C8222, C8223, C8224, C8225, C8226, C8227, C8228, C8229, C8230, C8231, C8232, C8233, C8234, C8235, C8236, C8237, C8238, C8239, C8240, C8241, C8242, C8243, C8244, C8245, C8246, C8247, C8248, C8249, C8250, C8251, C8252, C8253, C8254, C8255, C8256, C8257, C8258, C8259, C8260, C8261, C8262, C8263, C8264, C8265, C8266, C8267, C8268, C8269, C8280, C8281, C8282, C8283, C8284, C8285, C8286, C8287, C8288, C8289, C8290, C8291, C8292, C8293, C8294,	6	16

		C8295, C8296, C8297, C8298, C8299, C8300, C8301, C8302, C8303, C8304, C8305, C8306, C8307, C8308, C8309, C8310, C8311, C8312, C8313, C8314, C8315, C8316, C8317, C8318, C8319, C8330, C8331, C8332, C8333, C8334, C8335, C8336, C8337, C8338, C8339, C8350, C8351, C8352, C8353, C8354, C8355, C8356, C8357, C8358, C8359, C8370, C8371, C8372, C8373, C8374, C8375, C8376, C8377, C8378, C8379, C8380, C8381, C8382, C8383, C8384, C8385, C8386, C8387, C8388, C8389, C8390, C8391, C8392, C8393, C8394, C8395, C8396, C8397, C8398, C8399, C8400, C8401, C8402, C8403, C8404, C8405, C8406, C8407, C8408, C8409, C8410, C8411, C8412, C8413, C8414, C8415, C8416, C8417, C8418, C8419, C8440, C8441, C8442, C8443, C8444, C8445, C8446, C8447, C8448, C8449, C8460, C8461, C8462, C8463, C8464, C8465, C8466, C8467, C8468, C8469, C8470, C8471, C8472, C8473, C8474, C8475, C8476, C8477, C8478, C8479, C8490, C8491, C8492, C8493, C8494, C8495, C8496, C8497, C8498, C8499, C84A0, C84A1, C84A2, C84A3, C84A4, C84A5, C84A6, C84A7, C84A8, C84A9, C84Z0, C84Z1, C84Z2, C84Z3, C84Z4, C84Z5, C84Z6, C84Z7, C84Z8, C84Z9, C8510, C8511, C8512, C8513, C8514, C8515, C8516, C8517, C8518, C8519, C8520, C8521, C8522, C8523, C8524, C8525, C8526, C8527, C8528, C8529, C8580, C8581, C8582, C8583, C8584, C8585, C8586, C8587, C8588, C8589, C8590, C8591, C8592, C8593, C8594, C8595, C8596, C8597, C8598, C8599, C860, C861, C862, C863, C864, C865, C866, C880, C882, C883, C884, C888, C889, C9000, C9001, C9002, C9010, C9011, C9012, C9020, C9021, C9022, C9030, C9031, C9032, C960, C962, C9620, C9621, C9622, C9629, C964, C969, C96A, C96Z, D4729		
Metastatic Cancer	1960-1991, 20970-20975, 20979, 78951	C770, C771, C772, C773, C774, C775, C778, C779, C7800, C7801, C7802, C781, C782, C7830, C7839, C784, C785, C786, C787, C7880, C7889, C7900, C7901, C7902, C7910, C7911, C7919, C792, C7931, C7932, C7940, C7949, C7951, C7952, C7960, C7961, C7962, C7970, C7971, C7972, C7981, C7982, C7989, C799, C7B00, C7B01, C7B02, C7B03, C7B04, C7B09, C7B1, C7B8, C800, C801, R180	14	21
Solid Tumor w/o Metastasis	1400-1729, 1740-1759, 179-1958, 20900-20924, 20925-2093, 20930-20936, 25801-25803	C000, C001, C002, C003, C004, C005, C006, C008, C009, C01, C020, C021, C022, C023, C024, C028, C029, C030, C031, C039, C040, C041, C048, C049, C050, C051, C052, C058, C059, C060, C061,	7	15

		C062, C0680, C0689, C069, C07, C080, C081, C089, C090, C091, C098, C099, C100, C101, C102, C103, C104, C108, C109, C110, C111, C112, C113, C118, C119, C12, C130, C131, C132, C138, C139, C140, C142, C148, C153, C154, C155, C158, C159, C160, C161, C162, C163, C164, C165, C166, C168, C169, C170, C171, C172, C173, C178, C179, C180, C181, C182, C183, C184, C185, C186, C187, C188, C189, C19, C20, C210, C211, C212, C218, C220, C221, C222, C223, C224, C227, C228, C229, C23, C240, C241, C248, C249, C250, C251, C252, C253, C254, C257, C258, C259, C260, C261, C269, C300, C301, C310, C311, C312, C313, C318, C319, C320, C321, C322, C323, C328, C329, C33, C3400, C3401, C3402, C3410, C3411, C3412, C342, C3430, C3431, C3432, C3480, C3481, C3482, C3490, C3491, C3492, C37, C380, C381, C382, C383, C384, C388, C390, C399, C4000, C4001, C4002, C4010, C4011, C4012, C4020, C4021, C4022, C4030, C4031, C4032, C4080, C4081, C4082, C4090, C4091, C4092, C410, C411, C412, C413, C414, C419, C430, C4310, C4311, C43111, C43112, C4312, C43121, C43122, C4320, C4321, C4322, C4330, C4331, C4339, C434, C4351, C4352, C4359, C4360, C4361, C4362, C4370, C4371, C4372, C438, C439, C450, C451, C452, C457, C470, C4710, C4711, C4712, C4720, C4721, C4722, C473, C474, C475, C476, C478, C479, C480, C481, C482, C488, C490, C4910, C4911, C4912, C4920, C4921, C4922, C493, C494, C495, C496, C498, C499, C49A0, C49A1, C49A2, C49A3, C49A4, C49A5, C49A9, C4A0, C4A10, C4A11, C4A111, C4A112, C4A12, C4A121, C4A122, C4A20, C4A21, C4A22, C4A30, C4A31, C4A39, C4A4, C4A51, C4A52, C4A59, C4A60, C4A61, C4A62, C4A70, C4A71, C4A72, C4A8, C4A9, C50011, C50012, C50019, C50021, C50022, C50029, C50111, C50112, C50119, C50121, C50122, C50129, C50211, C50212, C50219, C50221, C50222, C50229, C50311, C50312, C50319, C50321, C50322, C50329, C50411, C50412, C50419, C50421, C50422, C50429, C50511, C50512, C50519, C50521, C50522, C50529, C50611, C50612, C50619, C50621, C50622, C50629, C50811, C50812, C50819, C50821, C50822, C50829, C50911, C50912, C50919, C50921, C50922, C50929, C510, C511, C512, C518, C519, C52, C530, C531, C538, C539, C540, C541, C542, C543, C548, C549, C55, C561, C562, C569, C5700, C5701, C5702, C5710, C5711, C5712, C5720, C5721, C5722, C573, C574, C577, C578, C579, C58, C600, C601, C602, C608, C609, C61, C6200, C6201, C6202, C6210, C6211, C6212,		
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		C6290, C6291, C6292, C6300, C6301, C6302, C6310, C6311, C6312, C632, C637, C638, C639, C641, C642, C649, C651, C652, C659, C661, C662, C669, C670, C671, C672, C673, C674, C675, C676, C677, C678, C679, C680, C681, C688, C689, C6900, C6901, C6902, C6910, C6911, C6912, C6920, C6921, C6922, C6930, C6931, C6932, C6940, C6941, C6942, C6950, C6951, C6952, C6960, C6961, C6962, C6980, C6981, C6982, C6990, C6991, C6992, C700, C701, C709, C710, C711, C712, C713, C714, C715, C716, C717, C718, C719, C720, C721, C7220, C7221, C7222, C7230, C7231, C7232, C7240, C7241, C7242, C7250, C7259, C729, C73, C7400, C7401, C7402, C7410, C7411, C7412, C7490, C7491, C7492, C750, C751, C752, C753, C754, C755, C758, C759, C760, C761, C762, C763, C7640, C7641, C7642, C7650, C7651, C7652, C768, C7A00, C7A010, C7A011, C7A012, C7A019, C7A020, C7A021, C7A022, C7A023, C7A024, C7A025, C7A026, C7A029, C7A090, C7A091, C7A092, C7A093, C7A094, C7A095, C7A096, C7A098, D030, D0310, D0311, D03111, D03112, D0312, D03121, D03122, D0320, D0321, D0322, D0330, D0339, D034, D0351, D0352, D0359, D0360, D0361, D0362, D0370, D0371, D0372, D038, D039, E3121, E3122, E3123		
Rheumatoid Arthritis/Collagen Vascular Disease	7010, 7100-7109, 7140-7149, 7200-7209, 725, 359.6, 357.1	L900, L940, L941, L943, M0500, M05011, M05012, M05019, M05021, M05022, M05029, M05031, M05032, M05039, M05041, M05042, M05049, M05051, M05052, M05059, M05061, M05062, M05069, M05071, M05072, M05079, M0509, M0510, M05111, M05112, M05119, M05121, M05122, M05129, M05131, M05132, M05139, M05141, M05142, M05149, M05151, M05152, M05159, M05161, M05162, M05169, M05171, M05172, M05179, M0519, M0520, M05211, M05212, M05219, M05221, M05222, M05229, M05231, M05232, M05239, M05241, M05242, M05249, M05251, M05252, M05259, M05261, M05262, M05269, M05271, M05272, M05279, M0529, M0530, M05311, M05312, M05319, M05321, M05322, M05329, M05331, M05332, M05339, M05341, M05342, M05349, M05351, M05352, M05359, M05361, M05362, M05369, M05371, M05372, M05379, M0539, M0540, M05411, M05412, M05419, M05421, M05422, M05429, M05431, M05432, M05439, M05441, M05442, M05449, M05451, M05452, M05459, M05461, M05462, M05469, M05471, M05472, M05479, M0549, M0550, M05511, M05512, M05519, M05521, M05522, M05529, M05531, M05532, M05539, M05541,	0	4

		M05542, M05549, M05551, M05552, M05559, M05561, M05562, M05569, M05571, M05572, M05579, M0559, M0560, M05611, M05612, M05619, M05621, M05622, M05629, M05631, M05632, M05639, M05641, M05642, M05649, M05651, M05652, M05659, M05661, M05662, M05669, M05671, M05672, M05679, M0569, M0570, M05711, M05712, M05719, M05721, M05722, M05729, M05731, M05732, M05739, M05741, M05742, M05749, M05751, M05752, M05759, M05761, M05762, M05769, M05771, M05772, M05779, M0579, M0580, M05811, M05812, M05819, M05821, M05822, M05829, M05831, M05832, M05839, M05841, M05842, M05849, M05851, M05852, M05859, M05861, M05862, M05869, M05871, M05872, M05879, M0589, M059, M0600, M06011, M06012, M06019, M06021, M06022, M06029, M06031, M06032, M06039, M06041, M06042, M06049, M06051, M06052, M06059, M06061, M06062, M06069, M06071, M06072, M06079, M0608, M0609, M061, M0620, M06211, M06212, M06219, M06221, M06222, M06229, M06231, M06232, M06239, M06241, M06242, M06249, M06251, M06252, M06259, M06261, M06262, M06269, M06271, M06272, M06279, M0628, M0629, M0630, M06311, M06312, M06319, M06321, M06322, M06329, M06331, M06332, M06339, M06341, M06342, M06349, M06351, M06352, M06359, M06361, M06362, M06369, M06371, M06372, M06379, M0638, M0639, M064, M0680, M06811, M06812, M06819, M06821, M06822, M06829, M06831, M06832, M06839, M06841, M06842, M06849, M06851, M06852, M06859, M06861, M06862, M06869, M06871, M06872, M06879, M0688, M0689, M069, M0800, M08011, M08012, M08019, M08021, M08022, M08029, M08031, M08032, M08039, M08041, M08042, M08049, M08051, M08052, M08059, M08061, M08062, M08069, M08071, M08072, M08079, M0808, M0809, M081, M0820, M08211, M08212, M08219, M08221, M08222, M08229, M08231, M08232, M08239, M08241, M08242, M08249, M08251, M08252, M08259, M08261, M08262, M08269, M08271, M08272, M08279, M0828, M0829, M083, M0840, M08411, M08412, M08419, M08421, M08422, M08429, M08431, M08432, M08439, M08441, M08442, M08449, M08451, M08452, M08459, M08461, M08462, M08469, M08471, M08472, M08479, M0848, M0880, M08811, M08812, M08819, M08821, M08822, M08829, M08831, M08832, M08839, M08841, M08842,		
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		M08849, M08851, M08852, M08859, M08861, M08862, M08869, M08871, M08872, M08879, M0888, M0889, M0890, M08911, M08912, M08919, M08921, M08922, M08929, M08931, M08932, M08939, M08941, M08942, M08949, M08951, M08952, M08959, M08961, M08962, M08969, M08971, M08972, M08979, M0898, M0899, M1200, M12011, M12012, M12019, M12021, M12022, M12029, M12031, M12032, M12039, M12041, M12042, M12049, M12051, M12052, M12059, M12061, M12062, M12069, M12071, M12072, M12079, M1208, M1209, M320, M3210, M3211, M3212, M3213, M3214, M3215, M3219, M328, M329, M3300, M3301, M3302, M3303, M3309, M3310, M3311, M3312, M3313, M3319, M3320, M3321, M3322, M3329, M3390, M3391, M3392, M3393, M3399, M340, M341, M342, M3481, M3482, M3483, M3489, M349, M3500, M3501, M3502, M3503, M3504, M3509, M351, M353, M355, M358, M359, M360, M368, M450, M451, M452, M453, M454, M455, M456, M457, M458, M459, M4600, M4601, M4602, M4603, M4604, M4605, M4606, M4607, M4608, M4609, M461, M4650, M4651, M4652, M4653, M4654, M4655, M4656, M4657, M4658, M4659, M4680, M4681, M4682, M4683, M4684, M4685, M4686, M4687, M4688, M4689, M4690, M4691, M4692, M4693, M4694, M4695, M4696, M4697, M4698, M4699, M488X1, M488X2, M488X3, M488X4, M488X5, M488X6, M488X7, M488X8, M488X9, M4980, M4981, M4982, M4983, M4984, M4985, M4986, M4987, M4988, M4989		
Coagulopathy	2860-2869, 2871, 2873-2875, 64930-64934, 28984	D65, D66, D67, D680, D681, D682, D68311, D68312, D68318, D6832, D684, D688, D689, D691, D693, D6941, D6942, D6949, D6951, D6959, D696, D7582, O99111, O99112, O99113, O99119, O9912, O9913	11	7
Obesity	2780, 27800, 27801, 27803, 64910-64914, V8530-V8539, V8541-V8545, V8554, 79391	E6601, E6609, E661, E662, E668, E669, O99210, O99211, O99212, O99213, O99214, O99215, R939, Z6830, Z6831, Z6832, Z6833, Z6834, Z6835, Z6836, Z6837, Z6838, Z6839, Z6841, Z6842, Z6843, Z6844, Z6845, Z6854	-5	-3
Weight Loss	260-2639, 78321-78322	E40, E41, E42, E43, E440, E441, E45, E46, E640, R634, R636	9	10
Fluid and Electrolyte Disorders	2760-2769	E860, E861, E869, E870, E871, E872, E873, E874, E875, E876, E8770, E8771, E8779, E878	11	8
Blood Loss Anemias	2800, 64820-64824	D500, O9081, O99011, O99012, O99013, O99019, O9902, O9903	-3	3



Deficiency Anemias	2801-2819, 28521-28529, 2859	D501, D508, D509, D510, D511, D512, D513, D518, D519, D520, D521, D528, D529, D530, D531, D532, D538, D539, D630, D631, D638, D64	-2	9
Alcohol Abuse	2910-2913, 2915, 2918, 29181, 29182, 29189, 2919, 30300-30393, 30500-30503	F1010, F1011, F10120, F10121, F10129, F1014, F10150, F10151, F10159, F10180, F10181, F10182, F10188, F1019, F1020, F1021, F10220, F10221, F10229, F10230, F10231, F10232, F10239, F1024, F10250, F10251, F10259, F1026, F1027, F10280, F10281, F10282, F10288, F1029, F10921, F1094, F10950, F10951, F10959, F1096, F1097, F10980, F10981, F10982, F10988, F1099	-1	6
Drug Abuse	2920, 29282-29289, 2929, 30400-30493, 30520-30593, 64830-64834, 292.81, 292.11, 292.12, 292.2	F1110, F1111, F11120, F11121, F11122, F11129, F1114, F11150, F11151, F11159, F11181, F11182, F11188, F1119, F1120, F1121, F11220, F11221, F11222, F11229, F1123, F1124, F11250, F11251, F11259, F11281, F11282, F11288, F1129, F1210, F1211, F12120, F12121, F12122, F12129, F12150, F12151, F12159, F12180, F12188, F1219, F1220, F1221, F12220, F12221, F12222, F12229, F1223, F12250, F12251, F12259, F12280, F12288, F1229, F1310, F1311, F13120, F13121, F13129, F1314, F13150, F13151, F13159, F13180, F13181, F13182, F13188, F1319, F1320, F1321, F13220, F13221, F13229, F13230, F13231, F13232, F13239, F1324, F13250, F13251, F13259, F1326, F1327, F13280, F13281, F13282, F13288, F1329, F1410, F1411, F14120, F14121, F14122, F14129, F1414, F14150, F14151, F14159, F14180, F14181, F14182, F14188, F1419, F1420, F1421, F14220, F14221, F14222, F14229, F1423, F1424, F14250, F14251, F14259, F14280, F14281, F14282, F14288, F1429, F1510, F1511, F15120, F15121, F15122, F15129, F1514, F15150, F15151, F15159, F15180, F15181, F15182, F15188, F1519, F1520, F1521, F15220, F15221, F15222, F15229, F1523, F1524, F15250, F15251, F15259, F15280, F15281, F15282, F15288, F1529, F1610, F1611, F16120, F16121, F16122, F16129, F1614, F16150, F16151, F16159, F16180, F16183, F16188, F1619, F1620, F1621, F16220, F16221, F16229, F1624, F16250, F16251, F16259, F16280, F16283, F16288, F1629, F1810, F1811, F18120, F18121, F18129, F1814, F18150, F18151, F18159, F1817, F18180, F18188, F1819, F1820, F1821, F18220, F18221, F18229, F1824, F18250, F18251, F18259, F1827, F18280, F18288, F1829, F1910, F1911, F19120, F19121, F19122, F19129, F1914, F19150, F19151, F19159, F1916, F1917, F19180, F19181, F19182, F19188, F1919, F1920, F1921, F19220, F19221, F19222, F19229, F19230, F19231, F19232, F19239, F1924, F19250, F19251, F19259, F1926, F1927, F19280, F19281, F19282, F19288,	-7	14

		F1929, F550, F551, F552, F553, F554, F558, O99320, O99321, O99322, O99323, O99324, O99325		
Psychosis	29500-2989, 300.16, 299.10, 299.11	F200, F201, F202, F203, F205, F2081, F2089, F209, F22, F23, F24, F250, F251, F258, F259, F28, F29, F3010, F3011, F3012, F3013, F302, F303, F304, F308, F309, F310, F3110, F3111, F3112, F3113, F312, F3130, F3131, F3132, F314, F315, F3160, F3161, F3162, F3163, F3164, F3170, F3171, F3172, F3173, F3174, F3175, F3176, F3177, F3178, F3181, F3189, F319, F324, F325, F3340, F3341, F3342, F348, F3481, F3489, F349, F39, F4489, F843	-5	10
Depression	296.21, 296.22, 296.23, 296.24, 298.0, 298.82, 625.4, 262.20, 311, 296.31, 296.32, 296.33, 296.34, 296.99, 296.30, 300.4, 301.12, 309.0, 309.1	F320, F321, F322, F323, F328, F3281, F3289, F329, F330, F331, F332, F333, F338, F339, F341, F4321	-5	4

## References:

1. Patrick PH. TAVR and SAVR: Current Treatment of Aortic Stenosis. *Clinical Medicine Insights: Cardiology*. 2012;6:CMC.S7540.
2. Herold J, Herold-Vlanti V, Sherif M, et al. Analysis of cardiovascular mortality, bleeding, vascular and cerebrovascular events in patients with atrial fibrillation vs. sinus rhythm undergoing transfemoral Transcatheter Aortic Valve Implantation (TAVR). *BMC Cardiovasc Disord*. 2017;17(1):298-298.
3. Mentias A, Saad M, Girotra S, et al. Impact of Pre-Existing and New-Onset Atrial Fibrillation on Outcomes After Transcatheter Aortic Valve Replacement. *JACC Cardiovascular interventions*. 2019;12(21):2119-2129.
4. Kalra R, Patel N, Doshi R, Arora G, Arora P. Evaluation of the Incidence of New-Onset Atrial Fibrillation After Aortic Valve Replacement. *JAMA Internal Medicine*. 2019;179(8):1122-1130.
5. Indja B, Woldendorp K, Vallely MP, Grieve SM. New Onset Atrial Fibrillation Following Transcatheter and Surgical Aortic Valve Replacement: A Systematic Review and Meta-Analysis. *Heart Lung Circ*. 2020;29(10):1542-1553.
6. Herold J, Herold-Vlanti V, Sherif M, et al. Analysis of cardiovascular mortality, bleeding, vascular and cerebrovascular events in patients with atrial fibrillation vs. sinus rhythm undergoing transfemoral Transcatheter Aortic Valve Implantation (TAVR). *BMC Cardiovascular Disorders*. 2017;17(1):298.
7. Björn R, Nissinen M, Lehto J, et al. Late incidence and recurrence of new-onset atrial fibrillation after isolated surgical aortic valve replacement. *The Journal of Thoracic and Cardiovascular Surgery*.
8. Motloch LJ, Reda S, Rottlaender D, et al. Postprocedural atrial fibrillation after transcatheter aortic valve implantation versus surgical aortic valve replacement. *Ann Thorac Surg*. 2012;93(1):124-131.
9. Tanawuttiwat T, O'Neill Brian P, Cohen Mauricio G, et al. New-Onset Atrial Fibrillation After Aortic Valve Replacement. *Journal of the American College of Cardiology*. 2014;63(15):1510-1519.
10. Vora AN, Dai D, Matsuoka R, et al. Incidence, Management, and Associated Clinical Outcomes of New-Onset Atrial Fibrillation Following Transcatheter Aortic Valve Replacement: An Analysis From the STS/ACC TVT Registry. *JACC Cardiovasc Interv*. 2018;11(17):1746-1756.
11. Saxena S, Javidi D. A Review of the Incidence and Management of New-Onset Atrial Fibrillation Post Transcatheter Aortic Valve Implantation. *American Journal of Biomedical Science & Research* 2020;8(2).
12. Tarantini G, Mojoli M, Windecker S, et al. Prevalence and Impact of Atrial Fibrillation in Patients With Severe Aortic Stenosis Undergoing Transcatheter Aortic Valve Replacement. *JACC: Cardiovascular Interventions*. 2016;9(9):937-946.
13. Ding Y, Wan M, Zhang H, Wang C, Dai Z. Comparison of postprocedural new-onset atrial fibrillation between transcatheter and surgical aortic valve replacement: A systematic review and meta-analysis based on 16 randomized controlled trials. *Medicine (Baltimore)*. 2021;100(28):e26613-e26613.

14. Chakravarty T, Patel A, Kapadia S, et al. Anticoagulation After Surgical or Transcatheter Bioprosthetic Aortic Valve Replacement. *Journal of the American College of Cardiology*. 2019;74(9):1190-1200.
15. Ong CS, Reinertsen E, Moonsamy P, et al. Late onset atrial fibrillation in patients undergoing surgical aortic valve replacement. *J Card Surg*. 2021.
16. Vora AN, Dai D, Matsuoka R, et al. Incidence, Management, and Associated Clinical Outcomes of New-Onset Atrial Fibrillation Following Transcatheter Aortic Valve Replacement: An Analysis From the STS/ACC TVT Registry. *JACC: Cardiovascular Interventions*. 2018;11(17):1746-1756.
17. Ejiofor JI, Yammine M, Harloff MT, et al. Reoperative Surgical Aortic Valve Replacement Versus Transcatheter Valve-in-Valve Replacement for Degenerated Bioprosthetic Aortic Valves. *Ann Thorac Surg*. 2016;102(5):1452-1458.