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New York State Ruptured/Dissected Thoracic Aortic Care Patients' Interventions and Two-Year Survival

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Title: New York State Ruptured/Dissected Thoracic Aortic Care Patients' Interventions and Two-Year Survival

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Research Question: What are the risk factors, treatments, and outcomes for patients *initially presenting to a hospital* with a *ruptured and/or dissected thoracic aortic aneurysm (TAA)*?

PURPOSE AND SPECIFIC AIMS:

Using the de-identified New York Statewide Planning and Research Cooperative System (SPARCS) comprehensive data system, this descriptive study seeks to analyze data for patients presenting initially with either a ruptured and/or dissected thoracic aortic aneurysm (TAA) from 2005-2018:

a. Patients with an initial diagnosis billing code for TAA rupture/dissection and/or an initial procedure billing code for TAA-related surgery between 2005-2018 will be included. Examples of exclusions may include:
    a. Patients with unknown UPID, unknown gender, age < 18, non-NY residents, and duplicate records will be excluded.
    b. Patients at the treating hospital will be included in the study. For example, exclusions include patients transferred out from external facilities.
    c. Patients with confounding conditions such as those with a concurrent diagnosis code for bicuspid aortic valve, a TAA-predisposing genetic disease, and cancer patients will be excluded. Cancer patients were defined based on Elixhauser/Charlson comorbities, which include any hematologic or solid tumor malignancy, except malignant neoplasm of the skin.
    d. Patients without any follow-up records will be excluded. Patients with an initial TAA rupture/dissection in 2017 or 2018 will be excluded to allow for consistent assessment of 2-year follow up.
    e. As an example, patients may be stratified by TAA dissection-only, TAA rupture-only, and concurrent TAA rupture and dissection.
b. Data on baseline demographics, prior comorbidities, admission acuity, and acuity and/or timing of surgery received will be extracted.

c. Across all of these categories, examples of outcomes range from risk-adjusted 30-outcomes to 2-year composite outcomes. 30-day operative death will be defined as death within the same hospital admission as the initial diagnosis even if it was after 30 days, or 30-day mortality in general. Composite outcomes include death, rupture/dissection after the index hospitalization, or emergent/urgent surgery after the index hospitalization.

The following hypotheses will be tested:

H(0): For TAA dissected-only, TAA rupture-only, and concurrent TAA rupture and dissection patients, there will be no differences in risk-adjusted outcomes across baseline demographics, prior comorbidities, admission type, and acuity and/or timing of surgery received, holding other factors constant.

- As an example, patients may be evaluated in three subgroups: index intervention, subsequent intervention, no intervention received (e.g. type B dissection medical management).

H(0): There will be no differences in baseline demographics, prior comorbidities, admission acuity, and acuity and/or timing of surgery received when comparing patients who initially presented with TAA dissection-only, TAA rupture-only, and concurrent TAA rupture and dissection.

Given this TAA project is research anticipated to advance the frontier of knowledge, ad hoc exploratory analyses (e.g., addressing other endpoints or expanding the time frame for follow-up) may be required to provide details to explain these hypothesis-based findings and/or to identify additional topics warranting future research (i.e., generate pilot data to initiate a new research project). Additional analyses may be performed to explore opportunities to develop future research projects.

BACKGROUND AND SIGNIFICANCE:

Ruptured/Dissected Thoracic Aortic Aneurysms

Thoracic aortic aneurysms (TAAs) are overall rare but when present are a major cause of morbidity and mortality in the United States [Kent, 2014]. TAAs have been mostly found in the ascending aorta but can also present in the aortic arch or descending thoracic aorta. In most cases, TAAs are diagnosed incidentally and are often referred to as a "silent killer." Previous studies have determined certain traditional risk factors that may contribute to the development of TAAs and subsequent complications of rupture or dissection, which include conditions that predispose to cystic medial degeneration of the aortic wall [Goldfinger et al., 2014].

Some of the major factors that typically lead to such degeneration include aging, specific inflammatory conditions, familial conditions, increases in aortic wall stress secondary to hypertension, and rapid aneurysm expansion. Autosomal dominant diseases that can predispose patients to TAAs include connective tissue diseases such as Marfan syndrome, Ehlers–Danlos syndrome, Loeys–Dietz syndrome, and Turner syndrome, but only make up 5% of TAAs. There also appears to be a difference in gender and TAA outcomes, where females are deemed to have

more adverse events with TAA with an increased likelihood of rupture. Anatomic location of the TAA has been associated with a variability in outcomes as well [Saeyeldin et al., 2019].

TAAs are usually asymptomatic until a certain threshold size is reached, at which point there is an increasing risk of dissection or rupture. The complications of rupture or dissection or both are considered to be an emergency with a high morbidity rate [Goldfinger et al., 2014]. According to current guidelines, the decision to pursue surgical intervention depends on the size and location of the TAA and whether or not there is a concurrent rupture/dissection. In most cases, surgical intervention involves resection and replacement or stenting of at least an aortic segment. There is currently a gap in the literature in regard to short-term and long-term outcomes of ruptured/dissected TAAs with and without surgical intervention.

Rationale of Study

Current guidelines state that symptomatic TAAs including ruptured TAAs and Type A aortic dissections should be operated on surgically [Hiratzka et al., 2010]. In the acute setting, Type B dissections are conventionally treated medically, but in practice they are often chronically treated with surgery after acute medical management [Alfson et al, 2017]. Contrary to what might be expected based on these guidelines, data from our patient population suggests that in practice, most ruptured and dissected TAA survivors were found to have no surgical intervention. Our study therefore assesses the status-quo of management trends of ruptured and dissected TAAs.

In addition, since ruptured and dissected TAAs carry such a high mortality, management in the acute setting is more focused on salvaging survival than consideration of longer-term outcomes [Geisbüsch et al, 2010]. We therefore have limited knowledge of how these ruptured and dissected TAA patients do down the road. This study therefore aims to assess the risk-factors associated with risk-adjusted outcomes of ruptured and dissected TAA patients. Furthermore, for this very high-risk TAA patient cohort, a screening algorithm may be developed from our findings to help guide future clinical care and optimize patient outcomes.

RESEARCH DESIGN AND METHODS:

Using the SPARCS database (i.e. IRB approval previously received by Dr. Allison J. McLarty), a retrospective observational cohort study will be performed using the SPARCS Health Facts dataset. Multivariable regression analysis using NYS records in the SPARCS dataset ranging from 2005- 2018 will be performed.

With the assistance of the SBU SOM Bioinformatics Department and Biostatistics Core Lab, the SPARCS database will be matched and merged to the enclosed coding listings to generate a study-specific de-identified thoracic aortic aneurysm database. Bioinformatics and Biostatistics team members will be responsible for providing the descriptive statistics listed, as well as providing a study-database for future analyses. SAS version 9.4 will be used to complete all necessary statistical analysis for this study. Given the concern for multiple comparisons performed, multivariable significance level will be set at 0.05, with all p-values reported for separate interpretation by readers. All secondary and tertiary analyses, as well as additional exploratory analyses, will use a p-value of <0.01.

Please note, the SPARCS database de-identified reports will be used, and a non-human subjects research (NHSR).

SAMPLE TABLES:

Table 1: Descriptive table for patient characteristics and risk factors by disease type

Variable	Total	TAA dissection only (N=)	TAA ruptured only (N=)	TAA ruptured and dissection (N=)	P-value
Patient Characteristics					
Gender Female Male					
Age group <80 >=80					
Race Black Non Black					
Insurance type Commercial Other					
Year group <2014 >=2014					
Risk Factors					
Admission type Elective Urgent/Emergent					
Carotid Disease					
Coronary Artery Disease					
Acute Visceral/Mesenteric Ischemia					
Hypotension					
Myocardial Infarction					
Arrhythmia					
Resuscitation					
Aortic Valve Replacement					

Elderly Women					

Table 2: Multivariate model results for 30-day operative death

Variable	Odds ratio (95% CI)	P-value*

Table 3: Multivariate model results for 2-year composite outcomes

Variable	Odds ratio (95% CI)	P-value*

Table 4: Univariate analysis of surgery categories stratified by disease type – 30-day operative death

Variable	Total	Without 30-day operative death	With 30-day operative death	P-value
All Patients (N=)				
Any Surgery				
Surgery Type No Surgery Elective Surgery Urgent Surgery Emergent Surgery				
TAA Dissection Only (N=)				
Any Surgery				
Surgery Type No Surgery Elective Surgery Urgent Surgery Emergent Surgery				
TAA Ruptured Only (N=)				
Any Surgery				
Surgery Type No Surgery Elective Surgery Urgent Surgery Emergent Surgery				
TAA Ruptured and Dissection (N=)				
Any Surgery				
Surgery Type No Surgery Emergent Surgery				

Table 5: Univariate analysis of surgery categories stratified by disease type – 2-year composite outcome.

Variable	Total	Without 2-year Composite Outcome	With 2-year Composite Outcome	P-value
All Patients (N=)				
Any Surgery				
Surgery Type				
No Surgery				
Elective Surgery				
Urgent Surgery				
Emergent Surgery				
TAA Dissection Only (N=)				
Any Surgery				
Surgery Type				
No Surgery				
Elective Surgery				
Urgent Surgery				
Emergent Surgery				
TAA Ruptured Only (N=)				
Any Surgery				
Surgery Type				
No Surgery				
Elective Surgery				
Urgent Surgery				
Emergent Surgery				
TAA Ruptured and Dissection (N=)				
Any Surgery				
Surgery Type				
No Surgery				
Emergent Surgery				

Table 6: O/E ratio for NYS region for 30-day operative death

Variable	Level	O/E Ratio (95% CI)
Region	Long Island	
	Mid/North	

Variable	Level	O/E Ratio (95% CI)
	NYC Area	
	West	

Table 7: Average annual facility volume by region

Variable	Level	Average annual facility volume							
		N	Mean	SD	Min	Median	Max	IQR	95% CI
Region	Long Island								
	Mid/North								
	NYC Area								
	West								
Total									

DIAGNOSIS AND PROCEDURE CODES

TAA Diagnosis Codes

Risk Factor	ICD-10	ICD-9	CPT
Atherosclerotic Disease of Aorta	I70.0	440.0	
Carotid Disease	I77.71, I65.21, I65.22, I65.23, I65.29, G45.1, I65.1 I65.01 I65.02 I65.03 I65.09	433.0-433.3, 435.8, 443.21	
Coronary Artery Disease	I25-I25.4, I25.6-I25.9	414-414.9	
Congestive Heart Failure	I50-I50.9, I09.9 I11.0 I13.0 I13.2 I25.5 I42.0 I42.5 - I42.9 I43 P29.0	428.0-428.9, 398.91 402.01 402.11 402.91 404.01 404.03 404.11 404.13 404.91 404.93	

		425.4 - 425.99, 414.8	
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, 405.91, 405.91, 405.99, 405.09, 405.19, 405.99	
Myocardial Infarction	I25.2, I21-I21.9, I21.A1, I21.A9, I22.0-I22.9	412, 410.00-410.92	
Aortic Valve Disease	I06.0, I06.2, I08.0, I08.2, I08.3, I35.0, I35.2, I06.1, I35.1, I35.8, I35.9	395.0, 395.2, 424.1, 396.3, 396.1	
Aortic Coarctation	Q25.1	747.1	
Diabetes mellitus	E08.00-E13.9	249.00-249.91, 250-250.03, 250.1-250.13, 250.2-250.23, 250.3-250.33, 250.4-250.43, 250.5-250.53, 250.6-250.63, 250.7-250.73, 250.8-250.83, 250.9,250.93	

Chronic Obstructive Pulmonary Disease	J41.0, J41.1, J41.8, J42, J43.0, J43.1, J43.2, J43.8, J43.9, J44.0, J44.1, J44.9 *Asthma and Bronchiectasis were not counted as a chronic obstructive pulmonary disease	491.0, 491.1, 491.20, 491.21, 491.22, 491.8, 491.9, 492.0, 492.8, 496 *Asthma and Bronchiectasis were not counted as a chronic obstructive pulmonary disease	
Tobacco/Smoking	Z72.0, F17.21-F17.299, Z87.891	V15.82, 305.1	
Cerebrovascular Disease	I60-I69.998, Z86.73, G46.0-G46.8, G45.0-G45.9	430-438.9, V12.54	
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	
Prior Percutaneous Coronary Intervention	Z98.61	V45.82	
Dialysis	Z99.2	V45.11	
Hyperlipidemia	E78.00, E78.01, E78.1, E78.2, E78.3, E78.41, E78.49, E78.5	272.0, 272.1, 272.2, 272.3, 272.4,	
Dyslipidemia- Literature Codes	E78.0-E78.9	272.0-272.5, 272.8, 272.9	
Dyslipidemia- Dr. Bilfinger Codes	E78.00, E78.01, E78.5, E78.79, E78.9	272.0, 272.4, 272.8, 272.9	
BMI: < 19.9 20-29 30-39 ³ 40.0	Z68.1 Z68.20-Z68.29 Z68.30-Z68.39 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 ³ 40.0: V85.41-V85.44	
Acute Renal Failure	N17.0-N17.9	584.5-584.9	

Chronic kidney disease Stage I Stage II Stage III Stage IV Stage V ESRD CKD, with dialysis CKD, without dialysis CKD + Hypertension	 N18.1 N18.2 N18.3 N18.4 N18.5 N18.6 Z99.2 N18.1-N18.9 I12.0, I12.9, I13.0, I13.1, I13.10, I13.11, I13.2	 585.1 585.2 585.3 585.4 585.5 585.6 V45.11 585.1-585.9 403.00-403.91, 404.00-404.93	
Obesity	E66-E66.9	278-278.3	
Resuscitation	5A12012, 5A19054	93.93, 99.60	92950
Arrhythmia	R00.0-R00.1, R00.8-R00.9 I44-I44.7, I45-I45.9, I47.0-I47.9, I48-I48.92, I49-I49.9,	426.0-426.9, 427.0-427.9, 785.0	
Hypovolemic Shock	R57.1	785.59	
Cardiogenic Shock	R57.0	785.51	
Hypotension	I95.0-I95.3, I95.89, I95.9	458.0-458.1, 458.29-458.9	
Aortic Valve Replacement	02RF07Z, 02RF0JZ, 02RF08Z, 02RF0KZ, 02RF37H, 02RF38H, 02RF3JH, 02RF3KH, 02RF37Z, 02RF38Z, 02RF3JZ, 02RF3KZ, 02RF47Z, 02RF48Z, 02RF4JZ, 02RF4KZ, Z95.2-Z95.4	35.21, 35.22, 35.05, 35.06, V43.3, V42.2	33405 33406 33410 33361 33362 33363 33364 33365 33366 33367 33368 33369
Chest Pain	I20.0-I20.9	413.1, 413.9, 411.1	
Liver dysfunction	K76.0-K76.9, K70-K70.9, K71.0-K71.9, K72.0-K74.9, B18.0-B18.9	570, 571.0-571.9, 572.2-572.8, 573.3-573.9, 070.22, 070.23, 070.32, 070.33, 070.44,	

		070.54, 070.59, 070.6, 070.9	
Immunosupression	Z79.51-Z79.52 D80.0-D89.9	V58.65, 279.00-279.9	
Cardiopulmonary Bypass Time	5A1221Z	39.61, 39.66	33367, 33368, 33369, 33390, 33391, 33405, 33406, 33410, 33858, 33859, 33863, 33864, 33871, 33870
Neurological Deficit (hemiplagia, paraplagia)	G81.00-G81.94, G82.2-G82.22	342.00-342.92, 344.1	
Atrial Fibrillation	Paroxysmal: I48.0 Persistent: I48.11-I48.19 Chronic: I48.20-I48.21 Unspecified: I48.91	427.31	
Atrial Flutter	Typical: I48.3 Atypical: I48.4 Unspecified: I48.92	427.32	
Use of Anticoagulants	Z79.01-Z79.02	V58.61, V58.63	
Use of Systemic Steroids	Z79.51-Z79.52	V58.65	
Acute Visceral/Mesenteric Ischemia	K55.0-K55.069	557.0	
Coma at Admission	R40.20	780.01	
Vasopressor Use	3E030XZ, 3E033XZ, 3E040XZ, 3E043XZ	0.17	

POST-OPERATIVE OUTCOME CODE TO BE USED IN CONJUNCTION WITH OUTCOME:	
Other post procedural cardiac functional disturbances following cardiac surgery	I97.190
Other post procedural cardiac functional disturbances following other surgery	I97.191
Other post procedural complications and disorders of the circulatory system, not elsewhere classified	I97.89

Disease		ICD10	ICD9
Thoracic Aortic Aneurysm (TAA)-non rupture		I71.2	441.2
TAA-ruptured		I71.1	441.1
TAA-dissection		I71.01	441.01
Bicuspid Aortic Valve Dx		Q23.1	746.4
Other	Marfan Syndrome	Q87.40	759.82
	Marfan Syndrome-CV manifestations	Q87.41, Q87.410, Q87.418	NA
	Marfan Syndrome-Aortic Dilation	Q87.418	NA
	Ehler-Danlos Syndrome	Q79.6 (Q79.60, Q79.61, Q79.62, Q79.63, Q79.69 were used instead)	756.83
	Turner Syndrome	Q96.0, Q96.9	758.6 (includes> than Turner syndrome)
	Ehler-Danlos Syndrome-Vascular	Q79.63	NA

TAA Procedure Codes

Open Approach					
ICD-10			**ICD-9**		
Replacement of Thoracic Aorta, Ascending/Arch with Autologous Tissue Substitute, Open Approach	02RX07Z		Resection of vessel with anastomosis, other thoracic vessels	38.35	
Replacement of Thoracic Aorta, Ascending/Arch with Zooplastic Tissue, Open Approach	02RX08Z		Resection of vessel with replacement, thoracic vessels	38.45	
Replacement of Thoracic Aorta, Ascending/Arch with Synthetic Substitute, Open Approach	02RX0JZ				
Replacement of Thoracic Aorta, Ascending/Arch with Nonautologous Tissue Substitute, Open Approach	02RX0KZ				

Replacement of Thoracic Aorta, Descending with Autologous Tissue Substitute, Open Approach	02RW07Z				
Replacement of Thoracic Aorta, Descending with Zooplastic Tissue, Open Approach	02RW08Z				
Replacement of Thoracic Aorta, Descending with Synthetic Substitute, Open Approach	02RW0JZ				
Replacement of Thoracic Aorta, Descending with Nonautologous Tissue Substitute, Open Approach	02RW0KZ				
Supplement Thoracic Aorta, Descending with Autologous Tissue Substitute, Open Approach	02UW07Z				
Supplement Thoracic Aorta, Descending with Zooplastic Tissue, Open Approach	02UW08Z				
Supplement Thoracic Aorta, Descending with Synthetic Substitute, Open Approach	02UW0JZ				
Supplement Thoracic Aorta, Descending with Nonautologous Tissue Substitute, Open Approach	02UW0KZ				
Supplement Thoracic Aorta, Ascending/Arch with Autologous Tissue Substitute, Open Approach	02UX07Z				
Supplement Thoracic Aorta, Ascending/Arch with Zooplastic Tissue, Open Approach	02UX08Z				
Supplement Thoracic Aorta, Ascending/Arch with Synthetic Substitute, Open Approach	02UX0JZ				
Supplement Thoracic Aorta, Ascending/Arch with Nonautologous Tissue Substitute, Open Approach	02UX0KZ				
Restriction of Thoracic Aorta, Descending with Intraluminal Device, Open Approach	02VW0DZ				
Restriction of Thoracic Aorta, Ascending/Arch with Intraluminal Device, Open Approach	02VX0DZ				
Repair Thoracic Aorta, Descending, Open Approach	02QW0ZZ				

Repair Thoracic Aorta, Ascending/Arch, Open Approach	02QX0 ZZ				
Percutaneous/Hybrid Approach					
ICD-10		**ICD-9**			
Replacement of Thoracic Aorta, Ascending/Arch with Autologous Tissue Substitute, Percutaneous Endoscopic Approach	02RX4 7Z		Endovascular implantation of graft in thoracic aorta	39.73	
Replacement of Thoracic Aorta, Ascending/Arch with Zooplastic Tissue, Percutaneous Endoscopic Approach	02RX4 8Z				
Replacement of Thoracic Aorta, Ascending/Arch with Synthetic Substitute, Percutaneous Endoscopic Approach	02RX4 JZ				
Replacement of Thoracic Aorta, Ascending/Arch with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach	02RX4 KZ				
Replacement of Thoracic Aorta, Descending with Autologous Tissue Substitute, Percutaneous Endoscopic Approach	02RW 47Z				
Replacement of Thoracic Aorta, Descending with Zooplastic Tissue, Percutaneous Endoscopic Approach	02RW 48Z				
Replacement of Thoracic Aorta, Descending with Synthetic Substitute, Percutaneous Endoscopic Approach	02RW 4JZ				
Replacement of Thoracic Aorta, Descending with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach	02RW 4KZ				
Supplement Thoracic Aorta, Descending with Autologous Tissue Substitute, Percutaneous Approach	02UW 37Z				

Supplement Thoracic Aorta, Descending with Zooplastic Tissue, Percutaneous Approach	02UW38Z				
Supplement Thoracic Aorta, Descending with Synthetic Substitute, Percutaneous Approach	02UW3JZ				
Supplement Thoracic Aorta, Descending with Nonautologous Tissue Substitute, Percutaneous Approach	02UW3KZ				
Supplement Thoracic Aorta, Descending with Autologous Tissue Substitute, Percutaneous Endoscopic Approach	02UW47Z				
Supplement Thoracic Aorta, Descending with Zooplastic Tissue, Percutaneous Endoscopic Approach	02UW48Z				
Supplement Thoracic Aorta, Descending with Synthetic Substitute, Percutaneous Endoscopic Approach	02UW4JZ				
Supplement Thoracic Aorta, Descending with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach	02UW4KZ				
Supplement Thoracic Aorta, Ascending/Arch with Autologous Tissue Substitute, Percutaneous Approach	02UX37Z				
Supplement Thoracic Aorta, Ascending/Arch with Zooplastic Tissue, Percutaneous Approach	02UX38Z				
Supplement Thoracic Aorta, Ascending/Arch with Synthetic Substitute, Percutaneous Approach	02UX3JZ				
Supplement Thoracic Aorta, Ascending/Arch with Nonautologous Tissue Substitute, Percutaneous Approach	02UX3KZ				
Supplement Thoracic Aorta, Ascending/Arch with Autologous Tissue Substitute, Percutaneous Endoscopic Approach	02UX47Z				

Supplement Thoracic Aorta, Ascending/Arch with Zooplastic Tissue, Percutaneous Endoscopic Approach	02UX48Z				
Supplement Thoracic Aorta, Ascending/Arch with Synthetic Substitute, Percutaneous Endoscopic Approach	02UX4JZ				
Supplement Thoracic Aorta, Ascending/Arch with Nonautologous Tissue Substitute, Percutaneous Endoscopic Approach	02UX4KZ				
Restriction of Thoracic Aorta, Ascending/Arch with Intraluminal Device, Percutaneous Approach	02VX3DZ				
Restriction of Thoracic Aorta, Ascending/Arch with Intraluminal Device, Percutaneous Endoscopic Approach	02VX4DZ				
Repair Thoracic Aorta, Ascending/Arch, Percutaneous Approach	02QX3ZZ				
Repair Thoracic Aorta, Ascending/Arch, Percutaneous Endoscopic Approach	02QX4ZZ				
Restriction of Thoracic Aorta, Descending with Intraluminal Device, Percutaneous Approach	02VW3DZ				
Restriction of Thoracic Aorta, Descending with Intraluminal Device, Percutaneous Endoscopic Approach	02VW4DZ				
Repair Thoracic Aorta, Descending, Percutaneous Approach	02QW3ZZ				
Repair Thoracic Aorta, Descending, Percutaneous Endoscopic Approach	02QW4ZZ				

CPT Description	CPT Code
TAA repair-sternotomy	33859, 33860, 33863, 33864, 33866, 33870, 33871, 33875
Ascending aorta graft, with cardiopulmonary bypass, includes valve suspension, when performed; for aortic dissection	33858
Ascending aorta graft, with cardiopulmonary bypass, includes valve suspension, when performed; for aortic disease other than dissection (eg, aneurysm)	33859
Ascending aorta graft, with cardiopulmonary bypass, includes valve suspension, when performed	33860
Ascending aorta graft, with cardiopulmonary bypass, with aortic root replacement using valved conduit and coronary reconstruction (eg, Bentall)	33863
Ascending aorta graft, with cardiopulmonary bypass with valve suspension, with coronary reconstruction and valve-sparing aortic root remodeling (eg, David Procedure, Yacoub Procedure)	33864
Aortic hemiarch graft including isolation and control of the arch vessels, beveled open distal aortic anastomosis extending under one or more of the arch vessels, and total circulatory arrest or isolated cerebral perfusion (List separately in addition to code for primary procedure)	33866
Transverse arch graft, with cardiopulmonary bypass	33870
Repair Procedures for Thoracic Aortic Aneurysm	33871
Descending thoracic aorta graft, with or without bypass	33875
TEVAR- Ascending & Arch-Not present	NO CODE
TEVAR-Descending	33880, 33881, 33883, 33884, 33886, 33889, 33891
Endovascular repair of descending thoracic aorta (eg, aneurysm, pseudoaneurysm, dissection, penetrating ulcer, intramural hematoma, or traumatic disruption); involving coverage of left subclavian artery origin, initial endoprosthesis plus descending thoracic aortic extension(s), if required, to level of celiac artery origin	33880

Endovascular repair of descending thoracic aorta (eg, aneurysm, pseudoaneurysm, dissection, penetrating ulcer, intramural hematoma, or traumatic disruption); not involving coverage of left subclavian artery origin, initial endoprosthesis plus descending thoracic aortic extension(s), if required, to level of celiac artery origin	33881
Placement of proximal extension prosthesis for endovascular repair of descending thoracic aorta (eg, aneurysm, pseudoaneurysm, dissection, penetrating ulcer, intramural hematoma, or traumatic disruption); initial extension	33883
Placement of proximal extension prosthesis for endovascular repair of descending thoracic aorta (eg, aneurysm, pseudoaneurysm, dissection, penetrating ulcer, intramural hematoma, or traumatic disruption); each additional proximal extension	33884
Placement of distal extension prosthesis(s) delayed after endovascular repair of descending thoracic aorta	33886
Open subclavian to carotid artery transposition performed in conjunction with endovascular repair of descending thoracic aorta, by neck incision, unilateral	33889
Bypass graft, with other than vein, transcervical retropharyngeal carotidcarotid, performed in conjunction with endovascular repair of descending thoracic aorta, by neck incision	33891

Procedure	**ICD-10**	**ICD-9**	**CPT**	
Aortic Valve Replacement (Open)	02RF07Z, 02RF0JZ, 02RF08Z, 02RF0KZ	35.21, 35.22, 35.11	33405, 33406, 33410	
Aortic Valve Open	024F07J, 024F08J, 024F0JJ, 025F0ZZ, 027F04Z, 027F0DZ, 027F0ZZ, 02BF0ZX, 02BF0ZZ, 02CF0ZZ, 02NF0ZZ, 02QF0ZJ, 02QF0ZZ, 02UF07J, 02UF07Z, 02UF08J, 02UF08Z, 02UF0JJ, 02UF0JZ, 02UF0KJ, 02UF0KZ, 02WF07Z, 02WF08Z, 02WF0JZ, 02WF0KZ	35.21, 35.22, 35.12	33405, 33406, 33411	*use these codes for exclusion

CABG	0210083, 0210088, 0210089, 021008C, 021008F, 021008W, 0210093, 0210098, 0210099, 021009C, 021009F, 021009W, 02100A3, 02100A8, 02100A9, 02100AC, 02100AF, 02100AW, 02100J3, 02100J8, 02100J9, 02100JC, 02100JF, 02100JW, 02100K3, 02100K8, 02100K9, 02100KC, 02100KF, 02100KW, 02100Z3, 02100Z8, 02100Z9, 02100ZC, 02100ZF, 0211083, 0211088, 0211089, 021108C, 021108F, 021108W, 0211093, 0211098, 0211099, 021109C, 021109F, 021109W, 02110A3, 02110A8, 02110A9, 02110AC, 02110AF, 02110AW, 02110J3, 02110J8, 02110J9, 02110JC, 02110JF, 02110JW, 02110K3, 02110K8, 02110K9, 02110KC, 02110KF, 02110KW, 02110Z3, 02110Z8, 02110Z9, 02110ZC, 02110ZF, 0212083, 0212088, 0212089, 021208C, 021208F, 021208W, 0212093, 0212098, 0212099, 021209C, 021209F, 021209W, 02120A3, 02120A8, 02120A9, 02120AC, 02120AF, 02120AW, 02120J3, 02120J8, 02120J9, 02120JC, 02120JF, 02120JW, 02120K3, 02120K8, 02120K9, 02120KC, 02120KF, 02120KW, 02120Z3, 02120Z8, 02120Z9, 02120ZC, 02120ZF, 0213083, 0213088, 0213089, 021308C, 021308F, 021308W, 0213093, 0213098, 0213099, 021309C, 021309F, 021309W, 02130A3, 02130A8, 02130A9, 02130AC, 02130AF, 02130AW, 02130J3, 02130J8, 02130J9, 02130JC, 02130JF, 02130JW, 02130K3, 02130K8, 02130K9, 02130KC, 02130KF, 02130KW, 02130Z3, 02130Z8, 02130Z9, 02130ZC, 02130ZF	36.10-36.19	33510, 33511, 33512, 33513, 33514, 33516, 33517, 33518, 33519, 33521, 33522, 33523, 33530, 33533, 33534, 33535, 33536	*use these codes for exclusion
Mitral Valve Replacement (Open)	02QG0ZZ, 02QG0ZE, 02RG07Z, 02RG08Z, 02RG0JZ, 02RG0KZ	35.12, 35.24, 35.23	33430	
Mitral Valve Open	02NG0ZZ, 02QG0ZZ, 02UG08Z, 025G0ZZ, 027G0ZZ, 02BG0ZX, 02BG0ZZ, 02UG07Z, 02UG0JZ, 02UG0KZ, 02VG0ZZ, 02RG08Z, 02QG0ZE, 027G04Z, 027G0DZ,	35.12, 35.24, 35.23	33422, 33425, 33426, 33427, 33430	*use these codes for exclusion

	02RG07Z, 02RG0JZ, 02RG0KZ, 024G082, 02UG08E, 024G072, 024G0J2, 024G0K2, 02UG07E, 02UG0JE, 02UG0KE, 02CG0ZZ, 02WG07Z, 02WG08Z, 02WG0JZ, 02WG0KZ			
Tricuspid Valve Replacement (Open)	02QJ0ZZ, 02QJ0ZG, 02RJ07Z, 02RJ0JZ, 02RJ08Z, 02RJ0KZ	35.14, 35.27, 35.28	33465	
Tricuspid Valve Open	02NJ0ZZ, 02QJ0ZZ, 02UJ08Z, 025J0ZZ, 027J0ZZ, 02BJ0ZX, 02BJ0ZZ, 02UJ07Z, 02UJ0JZ, 02UJ0KZ, 02QJ0ZG, 027J0DZ, 02RJ07Z, 02RJ0JZ, 02CJ0ZZ, 02RJ08Z, 027J04Z, 02RJ0KZ, 02WJ08Z, 02UJ08G, 024J082, 02UJ07G, 02UJ0JG, 02UJ0KG, 02WJ0JZ, 024J072, 024J0J2, 024J0K2, 02WJ07Z, 02WJ0KZ	35.14, 35.27, 35.28	33460, 33463, 33464, 33465, 33468	*use these codes for exclusion
Pulmonary Valve Replacement (Open)	02QH0ZZ, 02RH07Z, 02RH0JZ, 02RH08Z, 02RH0KZ	35.13, 35.26, 35.25	33475	
Pulmonary Valve Open	02NH0ZZ, 02QH0ZZ, 02UH08Z, 025H0ZZ, 027H0ZZ, 02BH0ZX, 02BH0ZZ, 02TH0ZZ, 02UH07Z, 02UH0JZ, 02UH0KZ, 02LH0ZZ, 027H0DZ, 02RH07Z, 02RH0JZ, 02CH0ZZ, 02RH08Z, 027H04Z, 02RH0KZ, 02LH0CZ, 02LH0DZ, 02WH08Z, 02WH0JZ, 02WH07Z, 02WH0KZ	35.13, 35.26, 35.25	33474, 33475, 33476, 33478	*use these codes for exclusion
Maze	02560ZZ, 02570ZZ, 025K0ZZ, 025L0ZZ, 02B60ZZ, 02B70ZZ, 02BK0ZZ, 02BL0ZZ, 02T80ZZ	37.33	33254, 33255, 33256	*use these codes for exclusion
Sternotomy	0P800ZZ	77.31	33202, 33365, 33955, 33956, 33963, 33964, 33985, 33986, 33988, 33989	

Thoracotomy	02JA0ZZ, 0WJC0ZZ, 0P810ZZ, 0P820ZZ, 0P850ZZ, 0P860ZZ, 0P890ZZ, 0P8B0ZZ	34.02	33366, 33140, 33202, 33203, 33236, 33238, 33243, 33955, 33956, 33963, 33964, 33985, 33986, 33988, 33989	
Other	Z95.1-Z95.818, Z95.9	V45.81, V43.3, V42.1, V42.2, V43.21, V43.22, V45.09, V45.00	.	*use these codes for exclusion: Note, this should be accompanied with either sternotomy or thoracotomy codes

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