

1 **Supplementary Material: Preoperative atrial fibrillation/flutter impact on risk-adjusted**
2 **repeat aortic intervention patients**

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18 **Supplementary Table 1. Risk factor ICD billing codes**

Risk factors	ICD-10	ICD-9	CPT codes
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	N18.1	585.1
Stage II	N18.2	585.2
Stage III	N18.3	585.3
Stage IV	N18.4	585.4
Stage V	N18.5	585.5
ESRD	N18.6	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,

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 or	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	
Procedures			
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)	I97.610, I97.611, I97.618, I97.51.	998.11, 998.2.	
Valvular	T82.01XA,	996.02.	

dysfunction (diagnosis) T82.02XA,
T82.03XA,
T82.09XA.

Unplanned coronary *: 0210, 0211, 36.1-36.19, 36.06, 36.07,
artery intervention 0212, 0213, 0270, 0.66
(procedure) 0271, 0272, 0273.

Aortic reintervention Diagnosis: Diagnosis: V43.3, V42.2.
(diagnosis or Z95.2-Z95.4.
procedure)
Procedure: Procedure: 35.21, 35.22, Procedure: 33405,
02RF07Z, 35.05, 35.06, 38.35, 33406, 33410,
02RF0JZ, 38.45, 39.73. 33361, 33362,
02RF08Z, 33363, 33364,
02RF0KZ, 33365, 33366,
02RF37H, 33367, 33368,
02RF38H, 33369.
02RF3JH,
02RF3KH,
02RF37Z,
02RF38Z,
02RF3JZ,
02RF3KZ,
02RF47Z,
02RF48Z,
02RF4JZ,
02RF4KZ,02RX07
Z, 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.

Other cardiac reason
(diagnosis or
procedure)

Diagnosis: Z95.810, Z95.811.	Diagnosis: V45.02, V43.21.	
Procedure: 02QG0ZE, 02QG0ZZ, 02QG3ZE, 02QG3ZZ, 02QG4ZE, 02QG4ZZ,	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.	Procedure: 0345T, 33418, 33419, 33425, 33426, 33427, 33430, 0483T, 0484T, 33463, 33464, 33465, 33475,

02QH0ZZ,	33470, 33471,
02QH3ZZ,	33472, 33473,
02QH4ZZ,	33474, 33440,
02QJ0ZG,	33411, 33412,
02QJ0ZZ,	33413.
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.

Deep sternal wound infection/mediastinitis (diagnosis)	J98.51, J85.3, T81.42XA, T81.43XA	519.2, 519.3, 513.1
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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

19 *: all specific codes under the general codes were used. CPT: Current procedural terminology;
20 BMI: ; SAVR: surgical aortic valve replacement; TAVR: transcatheter aortic valve
21 replacement; STS: society of thoracic surgeons; AKI: acute kidney injury; TIA: transient
22 ischemic attack; MI: myocardial infarction.
23

24 **Supplementary Table 2. Elixhauser comorbidity scores, ICD billing codes, and variable**
 25 **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,	6	5

		I2781, I2782, I2783, I2789, I279, I289, T800XXA, T82817A, T82818A		
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,	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,	-1	-1

	40491, 40402, 40412, 40492, 40403, 40413, 40493, 64270-64274, 64290-64294	O1043, O111, O112, O113, O114, O115, O119, I110, I119, I152, I158, I159, O161, O162, O163, O164, O165, O169		
Paralysis	3420 -3449, 43820-43853, 78072	G041, G800, G801, G802, G804, G808, 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,	5	6

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		
Neurodegenerativ e 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,	5	7

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, 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,	0	6

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Diabetes
complicated

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4940-24991

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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,	K254, K255, K256, K257, K259, K264, K265, K266, K267,	0	0

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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,	6	16

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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, C062, C0680, C0689, C069, C07, C080, C081, C089, C090, C091, C098, C099, C100, C101, C102, C103,	7	15

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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,	0	4

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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,	-1	6

F1099

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,	-7	14
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F1929, F550, F551, F552,
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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,	-5	10
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 F3178, F3181, F3189,
 F319, F324, F325, F3340,
 F3341, F3342, F348,
 F3481, F3489, F349, F39,
 F4489, F843

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
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26 ICD: Implantable cardiac defibrillator.

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31 **Supplementary Table 3. Univariate analysis for 30-day readmission among r-AVR patients**

Variable	Level	Total	Row percentage		Column percentage		P-value*
			Yes (15.0%)	No (85.0%)	Yes (15.0%)	No (85.0%)	
Primary factors							
Pre-operative AF/AFL (%)	No	54.5	12.6	87.4	46.0	56.0	0.1910
	Yes	45.5	17.8	82.2	54.0	44.0	
Surgery type (%)	r-SAV	61.4	16.6	83.4	68.0	60.2	0.2969
	R						
	Viv-T	38.6	12.4	87.6	32.0	39.8	
Type of admission (%)	Elective	80.5	16.0	84.0	86.0	79.6	0.2902
	Urgent	19.5	10.8	89.2	14.0	20.4	
Patients' characteristics							
Gender (%)	Female	40.4	13.3	86.7	36.0	41.2	0.4899
	Male	59.6	16.1	83.9	64.0	58.8	
Age (years) (mean ± std)	Unit = year	68.5 ± 13.89	71.34 ± 12.84	68.02 ± 14.03	71.34 ± 12.84	68.02 ± 14.03	0.1014
Race (%)	Black	7.5	12.0	88.0	6.0	7.8	0.7804
	Other	92.5	15.2	84.8	94.0	92.3	
Ethnicity (%)	Hispanic	3.9	15.4	84.6	4.0	3.9	1.0000
	Other/unknown	96.1	15.0	85.1	96.0	96.1	
Insurance (%)	Commercial	30.5	14.7	85.3	30.0	30.6	1.0000

	Medic	3.3	18.2	81.8	4.0	3.2	
	aid/Ot						
	her						
	Medic	66.2	14.9	85.1	66.0	66.2	
	are						
Risk factors							
Tobacco/Smoking (%)	No	60.2	15.9	84.1	64.0	59.5	0.5495
	Yes	39.8	13.5	86.5	36.0	40.5	
Hypertension (%)	No	19.2	12.5	87.5	16.0	19.7	0.5379
	Yes	80.8	15.6	84.4	84.0	80.3	
CHF (%)	No	69.2	13.9	86.2	64.0	70.1	0.3914
	Yes	30.8	17.5	82.5	36.0	29.9	
Cardiomyopathy (%)	No	90.4	13.9	86.1	84.0	91.6	0.0944
	Yes	9.6	25.0	75.0	16.0	8.5	
Diabetes mellitus (%)	No	97.6	15.3	84.7	100.0	97.2	0.3738
	Yes	2.4	0.0	100.0	0.0	2.8	
CAD (%)	No	52.1	10.9	89.1	38.0	54.6	0.0305
	Yes	47.9	19.4	80.6	62.0	45.4	
COPD (%)	No	88.3	14.2	85.8	84.0	89.1	0.3019
	Yes	11.7	20.5	79.5	16.0	10.9	
Stroke (%)	No	90.1	12.6	87.4	76.0	92.6	0.0003
	Yes	9.9	36.4	63.6	24.0	7.4	
Carotid stenosis (%)	No	97.0	14.5	85.5	94.0	97.5	0.1782
	Yes	3.0	30.0	70.0	6.0	2.5	
Cerebrovascular disease (%)	No	83.8	12.5	87.5	70.0	86.3	0.0040
	Yes	16.2	27.8	72.2	30.0	13.7	
Peripheral vascular disease (%)	No	94.0	15.0	85.0	94.0	94.0	1.0000
	Yes	6.0	15.0	85.0	6.0	6.0	
MI (%)	No	89.5	14.4	85.6	86.0	90.1	0.3780
	Yes	10.5	20.0	80.0	14.0	9.9	
PPM/ICD (%)	No	86.5	14.5	85.5	84.0	87.0	0.5704

	Yes	13.5	17.8	82.2	16.0	13.0	
Depression (%)	No	91.3	15.7	84.3	96.0	90.5	0.2741
	Yes	8.7	6.9	93.1	4.0	9.5	
Bipolar disorder (%)	No	99.4	14.8	85.2	98.0	99.7	0.2797
	Yes	0.6	50.0	50.0	2.0	0.4	
Schizophrenia (%)	No	99.4	15.1	84.9	100.0	99.3	1.0000
	Yes	0.6	0.0	100.0	0.0	0.7	
Dementia (%)	No	98.8	14.9	85.2	98.0	98.9	1.0000
	Yes	1.2	25.0	75.0	2.0	1.1	
Bicuspid aortic valve (%)	No	99.4	15.1	84.9	100.0	99.3	1.0000
	Yes	0.6	0.0	100.0	0.0	0.7	
Syncope (%)	No	99.7	15.0	85.0	100.0	99.7	1.0000
	Yes	0.3	0.0	100.0	0.0	0.4	
Dyspnea (%)	No	96.4	14.3	85.7	92.0	97.2	0.0909
	Yes	3.6	33.3	66.7	8.0	2.8	
Chest pain (%)	No	97.6	14.4	85.6	94.0	98.2	0.1008
	Yes	2.4	37.5	62.5	6.0	1.8	
Dialysis (%)	No	97.6	14.7	85.3	96.0	97.9	0.6024
	Yes	2.4	25.0	75.0	4.0	2.1	
Hyperlipidemia (%)	No	41.0	14.6	85.4	40.0	41.2	0.8739
	Yes	59.0	15.2	84.8	60.0	58.8	
Elevated lipoprotein (%)	No	100.0	15.0	85.0	100.0	100.0	.
History of mitral valve repair or replacement (%)	No	83.8	12.5	87.5	70.0	86.3	0.0040
	Yes	16.2	27.8	72.2	30.0	13.7	
AAA (%)	No	97.9	15.0	85.0	98.0	97.9	1.0000
	Yes	2.1	14.3	85.7	2.0	2.1	
Non rheumatic aortic stenosis (%)	No	41.0	19.0	81.0	52.0	39.1	0.0869
	Yes	59.0	12.2	87.8	48.0	60.9	
Rheumatic heart disease (%)	No	92.5	15.2	84.8	94.0	92.3	0.7728
	Yes	7.5	12.0	88.0	6.0	7.8	
Obstructive sleep apnea	No	88.0	15.0	85.0	88.0	88.0	0.9955

(%)	Yes	12.0	15.0	85.0	12.0	12.0	
Leukemia (%)	No	99.1	15.1	84.9	100.0	98.9	1.0000
	Yes	0.9	0.0	100.0	0.0	1.1	
Lymphoma (%)	No	99.1	15.1	84.9	100.0	98.9	1.0000
	Yes	0.9	0.0	100.0	0.0	1.1	
CKD, with dialysis (%)	No	97.6	14.7	85.3	96.0	97.9	0.6166
	Yes	2.4	25.0	75.0	4.0	2.1	
CKD, without dialysis (%)	No	73.1	12.7	87.3	62.0	75.0	0.0561
	Yes	27.0	21.1	78.9	38.0	25.0	
Obesity (%)	No	78.7	14.8	85.2	78.0	78.9	0.8893
	Yes	21.3	15.5	84.5	22.0	21.1	
Iron deficiency anemia (%)	No	86.5	14.9	85.1	86.0	86.6	0.9058
	Yes	13.5	15.6	84.4	14.0	13.4	
Rheumatoid arthritis/collagen vascular diseases (%)	No	95.5	14.4	85.6	92.0	96.1	0.2640
	Yes	4.5	26.7	73.3	8.0	3.9	
Fluid and electrolyte disorders (%)	No	98.5	14.9	85.1	98.0	98.6	1.0000
	Yes	1.5	20.0	80.0	2.0	1.4	
Pulmonary hypertension (%)	No	80.2	14.2	85.8	76.0	81.0	0.4142
	Yes	19.8	18.2	81.8	24.0	19.0	
Thrombocytopenia (%)	No	74.3	14.5	85.5	72.0	74.7	0.6929
	Yes	25.8	16.3	83.7	28.0	25.4	
Hypothyroidism (%)	No	85.3	15.8	84.2	90.0	84.5	0.3114
	Yes	14.7	10.2	89.8	10.0	15.5	
IABP (%)	No	97.6	14.7	85.3	96.0	97.9	0.6115
	Yes	2.4	25.0	75.0	4.0	2.1	
Elixhauser readmission index		25.42± 15.50	28.74 ± 14.80	24.83 ± 15.57	28.74 ± 14.80	24.83 ± 15.57	0.0921

32 For continuous variable, mean+/-std were reported. *: For categorical variables, *P*-values were
33 based on Chi-squared test with exact *P*-value from Monte Carlo simulation; for continuous
34 variables, *P*-value was based on Welch's *t*-test. r-AVR: Repeat aortic valve replacement;

35 AF/AFL: atrial fibrillation/flutter; r-SAVR: redo surgical aortic valve replacement; viv-TAVR:
36 valve-in-valve transcatheter aortic valve replacement; CHF: congestive heart failure; CAD:
37 coronary artery disease; COPD: chronic obstructive pulmonary disease; MI: myocardial
38 infarction; PPM: permanent pacemaker; ICD: implantable cardiac defibrillator; AAA: abdominal
39 aortic aneurysm; CKD: chronic kidney disease; IABP: intra-aortic balloon pump.
40

41 **Supplementary Table 4. Univariate analysis for STS MM composite endpoint among**
 42 **r-AVR patients**

Variable	Level	Total	Column				P-value*
			Row percentage		percentage		
			Yes (18.0%)	No (82.0%)	Yes (18.0%)	No (82.0%)	
Primary factors							
Pre-operative	No	54.5	14.8	85.2	45.0	56.6	0.1031
AF/AFL (%)	Yes	45.5	21.7	78.3	55.0	43.4	
Surgery type	r-SAVR	61.4	18.5	81.5	63.3	61.0	0.7312
(%)	Viv-TAVR	38.6	17.1	83.0	36.7	39.1	
Type of admission (%)	Elective	80.5	15.6	84.4	70.0	82.9	0.0228
	Urgent	19.5	27.7	72.3	30.0	17.2	
Patients' characteristics							
Gender (%)	Female	40.4	21.5	78.5	48.3	38.7	0.1678
	Male	59.6	15.6	84.4	51.7	61.3	
Age (years)	Unit = year	68.52 ±	71.08 ±	67.96 ±	71.08 ±	67.96 ±	0.0624
(mean ± std)		13.89	10.94	14.41	10.94	14.41	
Race (%)	Black	7.5	32.0	68.0	13.3	6.2	0.0573
	Other	92.5	16.8	83.2	86.7	93.8	
Ethnicity (%)	Hispanic	3.9	30.8	69.2	6.7	3.3	0.2642
	Other/unknown	96.1	17.5	82.6	93.3	96.7	
Insurance (%)	Commercial	30.5	10.8	89.2	18.3	33.2	0.0743
	Medicaid/Other	3.3	18.2	81.8	3.3	3.3	
	Medicare	66.2	21.3	78.7	78.3	63.5	
Risk factors							
Tobacco/Smoking (%)	No	60.2	24.4	75.6	81.7	55.5	0.0002
	Yes	39.8	8.3	91.7	18.3	44.5	

Hypertension (%)	No	19.2	9.4	90.6	10.0	21.2	0.0465
	Yes	80.8	20.0	80.0	90.0	78.8	
CHF (%)	No	69.2	16.5	83.6	63.3	70.4	0.2805
	Yes	30.8	21.4	78.6	36.7	29.6	
Cardiomyopathy (%)	No	90.4	16.6	83.4	83.3	92.0	0.0395
	Yes	9.6	31.3	68.8	16.7	8.0	
Diabetes mellitus (%)	No	97.6	16.9	83.1	91.7	98.9	0.0060
	Yes	2.4	62.5	37.5	8.3	1.1	
CAD (%)	No	52.1	21.8	78.2	63.3	49.6	0.0544
	Yes	47.9	13.8	86.3	36.7	50.4	
COPD (%)	No	88.3	18.6	81.4	91.7	87.6	0.3733
	Yes	11.7	12.8	87.2	8.3	12.4	
Stroke (%)	No	90.1	16.3	83.7	81.7	92.0	0.0154
	Yes	9.9	33.3	66.7	18.3	8.0	
Carotid stenosis (%)	No	97.0	17.0	83.0	91.7	98.2	0.0074
	Yes	3.0	50.0	50.0	8.3	1.8	
Cerebrovascular disease (%)	No	83.8	15.0	85.0	70.0	86.9	0.0013
	Yes	16.2	33.3	66.7	30.0	13.1	
Peripheral vascular disease (%)	No	94.0	18.8	81.2	98.3	93.1	0.1499
	Yes	6.0	5.0	95.0	1.7	6.9	
MI (%)	No	89.5	17.4	82.6	86.7	90.2	0.4255
	Yes	10.5	22.9	77.1	13.3	9.9	
PPM/ICD (%)	No	86.5	17.3	82.7	83.3	87.2	0.4238
	Yes	13.5	22.2	77.8	16.7	12.8	
Depression (%)	No	91.3	18.4	81.6	93.3	90.9	0.6246
	Yes	8.7	13.8	86.2	6.7	9.1	
Bipolar disorder (%)	No	99.4	18.1	81.9	100.0	99.3	1.0000
	Yes	0.6	0.0	100.0	0.0	0.7	
Schizophrenia (%)	No	99.4	18.1	81.9	100.0	99.3	1.0000
	Yes	0.6	0.0	100.0	0.0	0.7	

Dementia (%)	No	98.8	17.9	82.1	98.3	98.9	1.0000
	Yes	1.2	25.0	75.0	1.7	1.1	
Bicuspid aortic valve (%)	No	99.4	18.1	81.9	100.0	99.3	1.0000
	Yes	0.6	0.0	100.0	0.0	0.7	
Syncope (%)	No	99.7	18.0	82.0	100.0	99.6	1.0000
	Yes	0.3	0.0	100.0	0.0	0.4	
Dyspnea (%)	No	96.4	18.3	81.7	98.3	96.0	0.4925
	Yes	3.6	8.3	91.7	1.7	4.0	
Chest pain (%)	No	97.6	18.1	81.9	98.3	97.5	1.0000
	Yes	2.4	12.5	87.5	1.7	2.6	
Dialysis (%)	No	97.6	17.5	82.5	95.0	98.2	0.1535
	Yes	2.4	37.5	62.5	5.0	1.8	
Hyperlipidemia (%)	No	41.0	17.5	82.5	40.0	41.2	0.8595
	Yes	59.0	18.3	81.7	60.0	58.8	
Elevated lipoprotein (%)	No	100.0	18.0	82.0	100.0	100.0	.
History of mitral valve repair or replacement (%)	No	83.8	16.4	83.6	76.7	85.4	0.0960
	Yes	16.2	25.9	74.1	23.3	14.6	
AAA (%)	No	97.9	17.7	82.3	96.7	98.2	0.6169
	Yes	2.1	28.6	71.4	3.3	1.8	
Non rheumatic aortic stenosis (%)	No	41.0	17.5	82.5	40.0	41.2	0.8595
	Yes	59.0	18.3	81.7	60.0	58.8	
Rheumatic heart disease (%)	No	92.5	18.8	81.2	96.7	91.6	0.2719
	Yes	7.5	8.0	92.0	3.3	8.4	
OSA (%)	No	88.0	16.7	83.3	81.7	89.4	0.0940
	Yes	12.0	27.5	72.5	18.3	10.6	

Leukemia (%)	No	99.1	18.1	81.9	100.0	98.9	0.6358
	Yes	0.9	0.0	100.0	0.0	1.1	
Lymphoma (%)	No	99.1	18.1	81.9	100.0	98.9	0.6378
	Yes	0.9	0.0	100.0	0.0	1.1	
CKD, with dialysis (%)	No	97.6	17.5	82.5	95.0	98.2	0.1586
	Yes	2.4	37.5	62.5	5.0	1.8	
CKD, without dialysis (%)	No	73.1	12.3	87.7	50.0	78.1	<0.0001
	Yes	27.0	33.3	66.7	50.0	21.9	
Obesity (%)	No	78.7	16.0	84.0	70.0	80.7	0.0676
	Yes	21.3	25.4	74.7	30.0	19.3	
Iron deficiency anemia (%)	No	86.5	18.3	81.7	88.3	86.1	0.6509
	Yes	13.5	15.6	84.4	11.7	13.9	
Rheumatoid arthritis/collagen vascular diseases (%)	No	95.5	18.5	81.5	98.3	94.9	0.3236
	Yes	4.5	6.7	93.3	1.7	5.1	
Fluid and electrolyte disorders (%)	No	98.5	17.0	83.0	93.3	99.6	0.0055
	Yes	1.5	80.0	20.0	6.7	0.4	
Pulmonary hypertension (%)	No	80.2	17.2	82.8	76.7	81.0	0.4429
	Yes	19.8	21.2	78.8	23.3	19.0	
Thrombocytopenia (%)	No	74.3	16.5	83.5	68.3	75.6	0.2471
	Yes	25.8	22.1	77.9	31.7	24.5	
Hypothyroidism (%)	No	85.3	17.9	82.1	85.0	85.4	0.9366
	Yes	14.7	18.4	81.6	15.0	14.6	
IABP (%)	No	97.6	17.2	82.8	93.3	98.5	0.0364
	Yes	2.4	50.0	50.0	6.7	1.5	
Elixhauser mortality index		13.93 ± 10.92	21.02 ± 10.22	12.38 ± 10.46	21.02 ± 10.22	12.38 ± 10.46	< 0.0001

43 For continuous variable, mean \pm std were reported. *: For categorical variables, *P*-values were
 44 based on Chi-squared test with exact *P*-value from Monte Carlo simulation; for continuous
 45 variable, *P*-value was based on Welch's *t*-test. STS: Society of thoracic surgeons; MM: major
 46 morbidity; r-AVR: repeat aortic valve replacement; AF/AFL: atrial fibrillation/flutter; r-SAVR:
 47 redo surgical aortic valve replacement; viv-TAVR: valve-in-valve transcatheter aortic valve
 48 replacement; CHF: congestive heart failure; CAD: coronary artery disease; COPD: chronic
 49 obstructive pulmonary disease; MI: myocardial infarction; PPM: permanent pacemaker; ICD:
 50 implantable cardiac defibrillator; AAA: abdominal aortic aneurysm; OSA: ; CKD: chronic
 51 kidney disease; IABP: intra-aortic balloon pump.

52

53 **Supplementary Table 5. Multivariable model with propensity score for STS MM composite**
 54 **endpoint**

	Odds ratio	95% confidence interval	<i>P</i>-value
Propensity score	1.65	0.19-14.29	0.652
Pre-operative AF/AFL	1.16	0.60-2.25	0.653
Admission type: elective vs. urgent	0.56	0.28-1.14	0.111
Race: black vs. other	2.93	1.02-8.41	0.046
Insurance: commercial vs. medicare	0.67	0.28-1.63	0.663
Insurance: medicaid/other vs. medicare	0.66	0.11-4.10	0.663
Age	1.00	0.97-1.04	0.850
Elixhauser mortality score	1.07	1.04-1.10	< 0.0001

55 Model C-index = 0.754. STS: Society of thoracic surgeons; MM: major morbidity; AF/AFL:
 56 atrial fibrillation/flutter.

57

58 **Supplementary Table 6. Multivariable model with propensity score for STS 30-day**
 59 **readmission endpoint**

	Odds ratio	95% confidence interval	<i>P</i>-value
Propensity score	0.82	0.07-9.39	0.872
Pre-operative AF/AFL	1.16	0.59-2.29	0.660

Surgery type: viv-TAVR vs. r-SAVR	0.44	0.21-0.91	0.026
Cerebrovascular disease	2.63	1.15-6.02	0.023
Age	1.03	0.99-1.06	0.178
Elixhauser readmission score	1.02	0.997-1.04	0.100

60 Model C-index = 0.681. STS: Society of thoracic surgeons; AF/AFL: atrial fibrillation/flutter;
61 viv-TAVR: valve-in-valve transcatheter aortic valve replacement; r-SAVR: redo surgical aortic
62 valve replacement.

63