

Supplementary Online Content

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eMethods 1. Data Linkage and Management of Missing Data

eMethods 2. ICD-9/10 Codes for 1-Year Outcomes

eMethods 3. Covariates for Model Adjustment

eTable 1. Hospital Mitral Valve Surgery Volume-Outcome Association Stratified by Volume Quartiles

eTable 2. Patient and Procedural Characteristics of Patients Linked and Not Linked to CMS Claims Data

eTable 3. Hospital 1-Year Death Time to Event Rates

eTable 4. Hospital 1-Year Heart Failure Hospitalization Time to Event Rates

eTable 5. Hospital 1-Year Mitral Valve Reoperation Time to Event Rates

eTable 6. All Surgeon Mitral Valve Surgery Volume-Outcome Association Stratified by Volume Quartiles

eTable 7. Experienced Surgeons Mitral Valve Surgery Volume-Outcome Association Stratified by Volume Quartiles

eTable 8. All Surgeon 1-Year Mortality Time to Event Rates

eTable 9. All Surgeon 1-Year HF Hospitalization Rates

eTable 10. All Surgeon 1-Year MV Reoperation Time to Event Rates

eTable 11. Experienced Surgeons 1-Year Mortality Time to Event Rates

eTable 12. Experienced Surgeon 1-Year HF Hospitalization Time to Event Rates

eTable 13. Experienced Surgeons 1-Year MV Reoperation Time to Event Rates

eFigure 1. Hospital- and Surgeon-Level Annualized Mitral Valve Repair and Replacement (MVRR) Volume

eFigure 2. Hospital-Level Linked CMS 1-Year Risk-Adjusted Mortality

eFigure 3. Hospital-Level Linked CMS 1-Year HF Hospitalization

eFigure 4. Hospital-Level Linked CMS 1-Year MV Reoperation

eFigure 5. Experienced Surgeon Sensitivity Analysis: 30-Day Volume-Outcome Association for Mortality, Composite Major Morbidity Plus Mortality, Attempted MV Repair Rate, Successful MV Repair Rate

eFigure 6. All Surgeon-Linked CMS 1-Year Risk-Adjusted Mortality

eFigure 7. All Surgeon-Linked CMS 1-Year HF Hospitalization

eFigure 8. All Surgeon-Linked CMS 1-Year MV Reoperation

eFigure 9. Experienced Surgeon-Linked CMS 1-Year Risk-Adjusted Mortality

eFigure 10. Experienced Surgeon-Linked CMS 1-Year HF Hospitalization

eFigure 11. Experienced Surgeon-Linked CMS 1-Year MV Reoperation

eResults. Surgeons With 3 Years of Experience

This supplementary material has been provided by the authors to give readers additional information about their work.

eMethods 1. Data Linkage and Management of Missing Data

1. Linkage of the Society of Thoracic Surgeons Adult Cardiac Database to Centers for Medicare and Medicaid Services Administrative Claims:

As the STS ACSD does not collect outcomes beyond 30 days, the STS ACSD was linked with 100% part-A CMS claims data using combinations of non-unique indirect identifiers (Jacobs JP, Edwards FH, Shahian DM, et al. Successful linking of The Society of Thoracic Surgeons adult cardiac surgery database to Centers for Medicare and Medicaid Services Medicare data. *Ann Thorac Surg* 2010;90:1150–7). Records in the two databases were considered to be the same patient if they matched on a set of indirect identifiers including hospital, date of birth, sex, admission date, and discharge date. The matching algorithm required an exact match on a few of these variables or partial matching on a larger number of variables.

2. Management of Missing Data:

a) Missing covariates in the hierarchical models were less than 1% for all data elements except the following:

Covariates – overall population

IV-drug abuse (3.7%) , mediastinal radiation (2.6%), home oxygen (2.9%), liver disease (2%), medical insurance (1.4%), alcohol consumption (4%), white blood cells (1%), platelets (2.6%), ejection fraction (1.9%), HF more than 2 weeks before surgery (2.7%), Left Main disease (>50% stenosis) (1.1%), recent pneumonia (3.7%).

Covariates – Linked population

IV-drug abuse (3.7%) , mediastinal radiation (2.6%), home oxygen (3.2%), liver disease (2.2%), medical insurance (1.3 %), alcohol consumption (4%), platelets (2.6%), ejection fraction (1.8%), HF more than 2 weeks before surgery (2.7%), Left Main disease (>50% stenosis) (1.1%), recent pneumonia (3.8 %).

b) Missing covariate data was handled by single imputation:

c) Missing outcome data in the hierarchical models was:

Operative Mortality: 10.1%,

Composite: Operative Mortality (10.1%) + Major Morbidity (0.2%): Total 9.4%

MV Repair performed 0%

MV Repair successful: 11%

MV Repair attempted: 0.7% among Replacements, Total 0.1%

d) Missing outcome data was handled by multiple imputation. Specifically, we imputed outcome variables with missingness > 1% using PROC MI where the predictor variables were:

volcat1 volcat2 volcat3 volcat1alls volcat2alls volcat3alls age00 age60 age75 bsa1 bsa2 ifemale
bmi1 bmi2 idialysis creat100 creat150 hct1 hct2 ifemalehct1 ifemalehct2 wbc1 imedadp5days
imedadpidis ihypertn iimmsupp imedster ipvd ivdstena icvdpcarsurg iprcvint
ipayorge65comhmo ipayorlt65mcare insufmeq4 insufteq4 insufteq3 irecentarrhythafibcont
irecentarrhythafibparox chrlungdsev chrlungdmod chrlungdmild iremotecvdcva icvdtia
idiabinsulin icardpresunstabang icardpresstabang statueq2 insufaeq3 insufaeq4 ilmaindis
icardpresmi icigsmokercurr icigsmokerprev ipciepi ipciprior tvrepair surgdt ipayorlt65mcaid
ipayorlt65mcaremcaid ipayorlt65selfnone ipayorlt65other milt1d mi1to21d black hispanic
imedacei48 statusge2 iivdrugab imediastrad irecentpneu ihmo2 iliverdis alcoholnew classchf
platelets hdef;

The outcomes of interest were operative mortality, major morbidity, and successful mitral valve repair. For the outcome of successful mitral valve repair, we included only those patients undergoing mitral valve repair and merged the imputed outcome with the imputed datasets using the overall population.

Treating volume as a categorical variable, odds ratios for hospital volume quartiles were derived using a hierarchical model (proc glimmix) to account for hospitals and surgeon clustering (random intercepts) and patients as fixed effects. We ran the procedure for each imputed dataset (5 total) and then aggregate results using PROC MIANALYZE. For adjusted hierarchical models, we first ran a logistic regression (by _imputation_) to obtain the XBETA estimates for each patient and then used these to adjust volume estimates in hierarchical model.

Treating volume as a continuous variable, we used the same approach as in main analysis, but using PROC MIANALYZE to get final estimates (parameter estimates, coefficients) and covariance matrix (tcov=total covariance matrix) and p-values for linearity and association (testmultstat), aggregating results from hierarchical models run in imputed datasets (parmsest and parmscovb).

A similar approach was used for multiple imputation of the surgeon level analysis.

eMethods 2. ICD-9/10 Codes for 1-Year Outcomes

- Rehospitalization for Heart Failure:

ICD-9 codes: 398.x, 402.x1, 404.x1, 404.x3, 428.x (Primary Diagnosis Codes)

ICD-10 codes: I0981, I110, I130, I132, I502, I503, I504, I509 (Primary Diagnosis Codes)

- Mitral Valve Reoperation:

Reoperation – Mitral: MVr 35.12 / MVR 35.23 and 35.24 (Procedure codes)

ICD-10 codes: 027G04Z, 027G0DZ, 027G0ZZ, 02NG0ZZ, 02QG0ZZ, 02RG07Z, 02RG08Z, 02RG0JZ, 02RG0KZ

eMethods 3. Covariates for Model Adjustment

In all models:

Demographics: age, gender

Risk factors: BMI, BSA, dialysis, hypertension, immunosuppressant therapy, PVD, carotid surgery, IV-drug abuse, mediastinal radiation, home oxygen, liver disease, previous CV interventions, medical insurance, chronic lung disease, CVA more than 2 weeks before surgery, TIA, alcohol consumption, diabetes-insulin, urgent operative status

Labs: creatinine, hematocrit, white blood cells, platelets,

Medications prior to surgery: ADP Inhibitors within 5 days, ADP inhibitors discontinuation (days prior to surgery), steroids.

Valve disease: Aortic valve stenosis, Mitral severe insufficiency, Tricuspid moderate/severe insufficiency

Cardiac status: ejection fraction, atrial fibrillation, unstable angina, stable angina, heart failure within 2 weeks-class NYHA, HF more than 2 weeks before surgery.

Mortality models and long-term outcomes models: Aortic valve insufficiency moderate/severe, Left Main disease (>50% stenosis), STEMI/Not STEMI on admission.

Composite models: Cigarette smoking, former and current, prior PCI, PCI during episode of care, Tricuspid valve repair, surgery date, previous MI and timing, recent pneumonia, race, ACE inhibitors within 48 hours,

MV repair models: Aortic valve insufficiency moderate/severe, Left Main disease (>50% stenosis), STEMI/Not STEMI on admission, cigarette smoking, former and current, prior PCI, PCI during episode of care, Tricuspid valve repair, surgery date, previous MI and timing, recent pneumonia, race, ACE inhibitors within 48 hours

eTable 1. Hospital Mitral Valve Surgery Volume-Outcome Association Stratified by Volume Quartiles

Hospital Level Analysis	Volume	UNADJUSTED OR (95% CI)	P-value	ADJUSTED OR (95% CI)	P-value
Operative Mortality	Quartile 1 vs Q4	2.21(1.57,3.12)	<.0001	2.06(1.47,2.90)	<.0001
	Quartile 2 vs. Q4	1.95(1.53,2.50)	<.0001	1.78(1.40,2.26)	<.0001
	Quartile 3 vs. Q4	1.52(1.24,1.86)	<.0001	1.48(1.22,1.80)	<.0001
Composite	Quartile 1 vs Q4	1.40(1.18,1.67)	0.0001	1.35(1.15,1.60)	0.0004
	Quartile 2 vs. Q4	1.29(1.14,1.47)	<.0001	1.22(1.09,1.37)	0.0009
	Quartile 3 vs. Q4	1.04(0.93,1.15)	0.5099	1.03(0.93,1.13)	0.6071
Successful Repair	Quartile 1 vs Q4	0.57(0.38,0.87)	0.0043	0.50(0.34,0.72)	0.0002
	Quartile 2 vs. Q4	0.56(0.41,0.75)	0.0001	0.53(0.0,0.69)	<.0001
	Quartile 3 vs. Q4	0.62(0.49,0.80)	0.0002	0.59(0.47,0.73)	<.0001
Surgeon Level Analysis	Volume	UNADJUSTED OR (95% CI)	P-value	ADJUSTED OR (95% CI)	P-value
Operative Mortality	Quartile 1 vs Q4	2.74(2.05,3.67)	<.0001	2.25(1.68,3.01)	<.0001
	Quartile 2 vs. Q4	2.45(1.97,3.06)	<.0001	2.18(1.76,2.71)	<.0001
	Quartile 3 vs. Q4	1.47(1.21,1.80)	0.0001	1.32(1.08,1.60)	0.0056
Composite	Quartile 1 vs Q4	2.00(1.73,2.30)	<.0001	1.72(1.50,1.98)	<.0001
	Quartile 2 vs. Q4	1.57(1.40,1.75)	<.0001	1.40(1.26,1.55)	<.0001
	Quartile 3 vs. Q4	1.23(1.13,1.35)	<.0001	1.13(1.03,1.23)	0.0065
Successful Repair	Quartile 1 vs Q4	0.59(0.43,0.83)	0.0021	0.62(0.45,0.85)	0.0029
	Quartile 2 vs. Q4	0.65(0.51,0.82)	0.0004	0.65(0.52,0.81)	0.0002
	Quartile 3 vs. Q4	0.82(0.68,0.99)	0.0424	0.79(0.66,0.94)	0.0084

eTable 2. Patient and Procedural Characteristics of Patients Linked and Not Linked to CMS Claims Data

Variable	Level	CMS-LINKED:NO (N=9298)		CMS-LINKED:YES (N=18204)		P-value+
Demographics/SES						
Age	Median	9298	72.00	18204	73.00	<.0001
	25th		68.00		69.00	
	75th		77.00		78.00	
	Mean		73.19		73.88	
	STD		5.94		6.17	
	Min		65.00		65.00	
	Max		97.00		100.00	
	Missing (%)		0.00		0.00	
Gender	Female	4499	48.39	9464	51.99	<.0001
	Male	4799	51.61	8740	48.01	
Race	Other	147	1.58	193	1.06	<.0001
	Native American	11	0.12	27	0.15	
	Asian	279	3.00	309	1.70	
	Hispanic	432	4.65	374	2.05	
	Black	577	6.21	719	3.95	
	Caucasian	7754	83.39	16424	90.22	
	Missing	98	1.05	158	0.87	
Insurance	NONE	98	1.05	24	0.13	<.0001
	Government/Non US	121	1.30	35	0.19	
	Medicaid	110	1.18	12	0.07	
	Medicare	1493	16.06	5500	30.21	
	Private (HMO/Commercial)	7385	79.43	12401	68.12	

Variable	Level	CMS-LINKED:NO (N=9298)		CMS-LINKED:YES (N=18204)		P-value+
	Missing	91	0.98	232	1.27	
BMI	Median	9287	26.08	18181	25.92	0.0009
	25th		23.20		23.10	
	75th		29.70		29.37	
	Mean		26.92		26.71	
	STD		5.44		5.51	
	Min		7.55		7.34	
	Max		83.79		97.40	
	Missing(%)		0.12		0.13	
BSA	Median	9287	1.87	18181	1.86	0.0340
	25th		1.70		1.69	
	75th		2.04		2.03	
	Mean		1.88		1.87	
	STD		0.24		0.24	
	Min		1.12		1.02	
	Max		3.06		3.11	
	Missing(%)		0.12		0.13	
Risk Factors						
Diabetes Mellitus	Diabetes-Insulin	250	2.69	489	2.69	0.0090
	Diabetes-No Insulin	1216	13.08	2148	11.80	
	No Diabetes	7828	84.19	15561	85.48	
	Missing	4	0.04	6	0.03	
Hypertension	Yes	6935	74.59	13470	73.99	0.2829
	No	2358	25.36	4726	25.96	
	Missing	5	0.05	8	0.04	

Variable	Level	CMS-LINKED:NO (N=9298)		CMS-LINKED:YES (N=18204)		P-value+
Chronic Lung Disease	Lung Disease, Unknown Severity	174	1.87	299	1.64	0.0220
	Severe	355	3.82	665	3.65	
	Moderate	526	5.66	893	4.91	
	Mild	1080	11.62	2052	11.27	
	No	7109	76.46	14188	77.94	
	Missing	54	0.58	107	0.59	
Dialysis	Yes	66	0.71	146	0.80	0.4089
	No	9227	99.24	18051	99.16	
	Missing	5	0.05	7	0.04	
Last Creatinine	Median	9275	1.00	18179	1.00	0.7363
	25th		0.80		0.80	
	75th		1.20		1.20	
	Mean		1.04		1.05	
	STD		0.51		0.52	
	Min		0.20		0.10	
	Max		17.00		12.70	
	Missing(%)		0.25		0.14	
Smoking	Current Smoker	408	4.39	706	3.88	<.0001
	Past Smoker	2234	24.03	3975	21.84	
	Never Smoker	6634	71.35	13491	74.11	
	Missing	22	0.24	32	0.18	
Immunocompromised	Yes	251	2.70	542	2.98	0.1910
	No	9028	97.10	17618	96.78	
	Missing	19	0.20	44	0.24	
PVD	Yes	484	5.21	966	5.31	0.7291
	No	8801	94.65	17221	94.60	

Variable	Level	CMS-LINKED:NO (N=9298)		CMS-LINKED:YES (N=18204)		P-value+
	Missing	13	0.14	17	0.09	
CVD-CVA	CVD - No CVA	503	5.41	1048	5.76	0.4492
	CVD - CVA	454	4.88	909	4.99	
	No CVD	8326	89.55	16221	89.11	
	Missing	15	0.16	26	0.14	
<u>Hemodynamics/Cardiac Status</u>						
Ejection Fraction*	Median	9158	60.00	17849	60.00	0.1096
	25th		53.00		53.00	
	75th		63.00		63.00	
	Mean		56.80		57.09	
	STD		10.12		9.93	
	Min		5.00		2.00	
	Max		86.00		90.00	
	Missing(%)		1.51		1.95	
Congestive HF within 2 weeks	Yes	4782	51.43	9009	49.49	0.0011
	No	4469	48.06	9151	50.27	
	Missing	47	0.51	44	0.24	
NYHA Class	IV	840	17.57	1362	15.12	0.0004
	III	2076	43.41	3982	44.20	
	II	1470	30.74	2955	32.80	
	I	313	6.55	534	5.93	
	Missing	83	1.74	176	1.95	
<u>Mitral Disease Details</u>						

Variable	Level	CMS-LINKED:NO (N=9298)		CMS-LINKED:YES (N=18204)		P-value+
Mitral Valve Stenosis	No	9298	100.00	18204	100.00	.
Mitral Insufficiency	Severe	8674	93.29	16929	93.00	0.3649
	Moderate to Severe	624	6.71	1275	7.00	
Tricuspid Disease Details						
Tricuspid Insufficiency	N/A or Not Documented	116	1.25	216	1.19	0.2124
	Severe	953	10.25	1867	10.26	
	Moderate	2033	21.86	4075	22.39	
	Mild	2821	30.34	5339	29.33	
	Trivial	1246	13.40	2347	12.89	
	None	2104	22.63	4308	23.67	
	Missing	25	0.27	52	0.29	
Operative						
Operative Status	Urgent	1579	16.98	2719	14.94	<.0001
	Elective	7719	83.02	15485	85.06	

eTable 3. Hospital 1-Year Death Time to Event Rates

MVRR Volume Quartiles	t2	Unadjusted Failure Estimates (95% CI)	Adjusted Failure Estimates (95% CI)
1=Q1	30	0.0370 (0.0293, 0.0447)	0.0352 (0.028, 0.0423)
	365	0.1026 (0.0831, 0.1217)	0.0958 (0.0786, 0.1127)
	730	0.1452 (0.1184, 0.1711)	0.1338 (0.1109, 0.1560)
	1095	0.1973 (0.1621, 0.2311)	0.1795 (0.1504, 0.2077)
	1420	0.2420 (0.1998, 0.2819)	0.2182 (0.1841, 0.2509)
2=Q2	30	0.0292 (0.0248, 0.0337)	0.0263 (0.0224, 0.0303)
	365	0.0817 (0.0712, 0.0922)	0.0730 (0.0639, 0.0821)
	730	0.1162 (0.1018, 0.1304)	0.1030 (0.0908, 0.1151)
	1095	0.1590 (0.1398, 0.1777)	0.1399 (0.1241, 0.1555)
	1420	0.1960 (0.173, 0.2185)	0.1717 (0.1529, 0.1901)
3=Q3	30	0.0241 (0.0211, 0.0271)	0.0239 (0.0209, 0.0268)
	365	0.0677 (0.061, 0.0743)	0.0665 (0.0603, 0.0728)
	730	0.0965 (0.0875, 0.1054)	0.0942 (0.0859, 0.1024)
	1095	0.1326 (0.1207, 0.1443)	0.1283 (0.1176, 0.1389)
	1420	0.1641 (0.1497, 0.1783)	0.1579 (0.1451, 0.1705)
4=Q4	30	0.0220 (0.0198, 0.0241)	0.0222 (0.02, 0.0243)
	365	0.0618 (0.0579, 0.0658)	0.0620 (0.0582, 0.0658)
	730	0.0883 (0.0833, 0.0934)	0.0880 (0.0832, 0.0927)
	1095	0.1216 (0.1151, 0.1280)	0.1202 (0.1142, 0.1262)
	1420	0.1507 (0.1429, 0.1585)	0.1482 (0.141, 0.1554)

eTable 4. Hospital 1-Year Heart Failure Hospitalization Time to Event Rates

MVRR Volume Quartile s	t2	Unadjusted HF Incidence Estimates (95% CI)	Adjusted HF Incidence Estimates (95% CI)
1	30	0.0374 (0.0277, 0.0469)	0.0358 (0.0268, 0.0447)
	365	0.0965 (0.073, 0.1194)	0.0924 (0.0713, 0.1130)
	730	0.1221 (0.0928, 0.1504)	0.1171 (0.0912, 0.1422)
	1095	0.1451 (0.1107, 0.1782)	0.1393 (0.1092, 0.1683)
	1460	0.1667 (0.1275, 0.2042)	0.1600 (0.1261, 0.1925)
2	30	0.0416 (0.0352, 0.0480)	0.0359 (0.0304, 0.0413)
	365	0.1072 (0.0928, 0.1213)	0.0926 (0.0807, 0.1043)
	730	0.1353 (0.1176, 0.1527)	0.1173 (0.1028, 0.1316)
	1095	0.1606 (0.1399, 0.1808)	0.1395 (0.1227, 0.1560)
	1460	0.1843 (0.1608, 0.2072)	0.1603 (0.1413, 0.1789)
3	30	0.0313 (0.0273, 0.0353)	0.0303 (0.0265, 0.0340)
	365	0.0813 (0.0727, 0.0898)	0.0791 (0.0712, 0.0869)
	730	0.1030 (0.0925, 0.1135)	0.1006 (0.091, 0.1102)
	1095	0.1227 (0.1103, 0.1349)	0.1202 (0.1089, 0.1313)
	1460	0.1413 (0.1271, 0.1553)	0.1385 (0.1257, 0.1512)
4	30	0.0283 (0.0257, 0.0310)	0.0285 (0.0259, 0.0311)
	365	0.0737 (0.069, 0.0784)	0.0747 (0.0702, 0.0792)
	730	0.0936 (0.088, 0.0991)	0.0952 (0.0898, 0.1005)
	1095	0.1116 (0.1051, 0.1181)	0.1138 (0.1076, 0.1200)
	1460	0.1286 (0.121, 0.1362)	0.1313 (0.124, 0.1386)

eTable 5. Hospital 1-Year Mitral Valve Reoperation Time to Event Rates

MVRR Volume Quartiles	t2	Unadjusted HF Incidence Estimates (95% CI)	Adjusted HF Incidence Estimates (95% CI)
1	30	0.0015 (0.0004, 0.0026)	0.0015 (0.0003, 0.0026)
	365	0.0147 (0.0059, 0.0234)	0.0145 (0.0057, 0.0231)
	730	0.0219 (0.0089, 0.0347)	0.0215 (0.0087, 0.0342)
	1095	0.0298 (0.0122, 0.0470)	0.0291 (0.0118, 0.0460)
	1460	0.0343 (0.0141, 0.0541)	0.0334 (0.0136, 0.0528)
2	30	0.0011 (0.0004, 0.0017)	0.0010 (0.0004, 0.0017)
	365	0.0107 (0.0062, 0.0151)	0.0102 (0.0059, 0.0144)
	730	0.0159 (0.0095, 0.0224)	0.0152 (0.009, 0.0213)
	1095	0.0217 (0.013, 0.0303)	0.0205 (0.0122, 0.0287)
	1460	0.0250 (0.015, 0.0350)	0.0236 (0.014, 0.0330)
3	30	0.0009 (0.0004, 0.0014)	0.0009 (0.0004, 0.0013)
	365	0.0086 (0.0059, 0.0113)	0.0085 (0.0058, 0.0112)
	730	0.0129 (0.009, 0.0168)	0.0127 (0.0088, 0.0166)
	1095	0.0176 (0.0123, 0.0228)	0.0172 (0.012, 0.0223)
	1460	0.0203 (0.0142, 0.0263)	0.0198 (0.0138, 0.0257)
4	30	0.0010 (0.0005, 0.0015)	0.0010 (0.0005, 0.0015)
	365	0.0096 (0.0079, 0.0114)	0.0098 (0.008, 0.0117)
	730	0.0144 (0.012, 0.0168)	0.0147 (0.0123, 0.0171)
	1095	0.0196 (0.0166, 0.0227)	0.0199 (0.0167, 0.0230)
	1460	0.0226 (0.019, 0.0262)	0.0228 (0.0191, 0.0265)

eTable 6. All Surgeon Mitral Valve Surgery Volume-Outcome Association Stratified by Volume Quartiles

Outcome variable	Volume	UNADJUSTED OR (95% CI)	P-value	ADJUSTED OR (95% CI)	P-value
Operative Mortality	Quartile 1 vs Q4	2.74(2.05,3.67)	<.0001	2.25(1.68,3.01)	<.0001
	Quartile 2 vs. Q4	2.45(1.97,3.06)	<.0001	2.18(1.76,2.71)	<.0001
	Quartile 3 vs. Q4	1.47(1.21,1.80)	0.0001	1.32(1.08,1.60)	0.0056
Composite	Quartile 1 vs Q4	2.00(1.73,2.30)	<.0001	1.72(1.50,1.98)	<.0001
	Quartile 2 vs. Q4	1.57(1.40,1.75)	<.0001	1.40(1.26,1.55)	<.0001
	Quartile 3 vs. Q4	1.23(1.13,1.35)	<.0001	1.13(1.03,1.23)	0.0065
REPAIR performed	Quartile 1 vs Q4	0.29(0.25,0.34)	<.0001	0.33(0.28,0.39)	<.0001
	Quartile 2 vs. Q4	0.40(0.35,0.46)	<.0001	0.43(0.37,0.49)	<.0001
	Quartile 3 vs. Q4	0.55(0.49,0.62)	<.0001	0.59(0.53,0.67)	<.0001
REPAIR Success	Quartile 1 vs Q4	0.59(0.43,0.83)	0.0021	0.62(0.45,0.85)	0.0029
	Quartile 2 vs. Q4	0.65(0.51,0.82)	0.0004	0.65(0.52,0.81)	0.0002
	Quartile 3 vs. Q4	0.82(0.68,0.99)	0.0424	0.79(0.66,0.94)	0.0084
REPAIR Attempted	Quartile 1 vs Q4	0.31(0.26,0.36)	<.0001	0.34(0.29,0.41)	<.0001
	Quartile 2 vs. Q4	0.40(0.35,0.46)	<.0001	0.43(0.37,0.50)	<.0001
	Quartile 3 vs. Q4	0.56(0.50,0.64)	<.0001	0.61(0.54,0.70)	<.0001

eTable 7. Experienced Surgeons Mitral Valve Surgery Volume-Outcome Association Stratified by Volume Quartiles

Outcome variable	Volume	UNADJUSTED OR (95% CI)	P-value	ADJUSTED OR (95% CI)	P-value
Operative Mortality	Quartile 1 vs Q4	2.82(2.10,3.80)	<.0001	2.30(1.71,3.10)	<.0001
	Quartile 2 vs. Q4	2.23(1.77,2.80)	<.0001	1.98(1.58,2.48)	<.0001
	Quartile 3 vs. Q4	1.42(1.16,1.74)	0.0009	1.26(1.03,1.54)	0.0246
Composite	Quartile 1 vs Q4	1.98(1.71,2.29)	<.0001	1.68(1.45,1.94)	<.0001
	Quartile 2 vs. Q4	1.51(1.35,1.69)	<.0001	1.35(1.21,1.50)	<.0001
	Quartile 3 vs. Q4	1.24(1.12,1.36)	<.0001	1.12(1.03,1.23)	0.0112
REPAIR performed	Quartile 1 vs Q4	0.26(0.22,0.31)	<.0001	0.31(0.26,0.36)	<.0001
	Quartile 2 vs. Q4	0.36(0.31,0.41)	<.0001	0.39(0.34,0.45)	<.0001
	Quartile 3 vs. Q4	0.50(0.44,0.57)	<.0001	0.55(0.49,0.63)	<.0001
REPAIR Success	Quartile 1 vs Q4	0.56(0.38,0.82)	0.0034	0.60(0.42,0.86)	0.0061
	Quartile 2 vs. Q4	0.67(0.52,0.86)	0.0019	0.67(0.53,0.85)	0.0008
	Quartile 3 vs. Q4	0.86(0.70,1.06)	0.1534	0.84(0.69,1.01)	0.0644
REPAIR Attempted	Quartile 1 vs Q4	0.28(0.23,0.33)	<.0001	0.31(0.26,0.37)	<.0001
	Quartile 2 vs. Q4	0.38(0.33,0.44)	<.0001	0.41(0.35,0.48)	<.0001
	Quartile 3 vs. Q4	0.51(0.44,0.58)	<.0001	0.56(0.48,0.64)	<.0001

eTable 8. All Surgeon 1-Year Mortality Time to Event Rates

MVRR Volume Quartiles	t2	Unadjusted Survival Estimates (95% CI)	Adjusted Survival Estimates (95% CI)	Unadjusted Failure Estimates (95% CI)	Adjusted Failure Estimates (95% CI)
1=Q1	30	0.9638 (0.9569, 0.9708)	0.9657 (0.9592, 0.9722)	0.0362 (0.0292, 0.0431)	0.0343 (0.0278, 0.0408)
	365	0.8995 (0.8825, 0.9169)	0.9063 (0.8912, 0.9216)	0.1005 (0.0831, 0.1175)	0.0937 (0.0784, 0.1088)
	730	0.8578 (0.8346, 0.8816)	0.8691 (0.8492, 0.8894)	0.1422 (0.1184, 0.1654)	0.1309 (0.1106, 0.1508)
	1095	0.8067 (0.7766, 0.8379)	0.8242 (0.799, 0.8501)	0.1933 (0.1621, 0.2234)	0.1758 (0.1499, 0.2010)
	1420	0.7630 (0.7274, 0.8003)	0.7863 (0.7571, 0.8166)	0.2370 (0.1997, 0.2726)	0.2137 (0.1834, 0.2429)
2=Q2	30	0.9684 (0.9637, 0.9732)	0.9715 (0.9672, 0.9757)	0.0316 (0.0268, 0.0363)	0.0285 (0.0243, 0.0328)
	365	0.9119 (0.9008, 0.9231)	0.9212 (0.9116, 0.9308)	0.0881 (0.0769, 0.0992)	0.0788 (0.0692, 0.0884)
	730	0.8749 (0.8598, 0.8902)	0.8891 (0.8764, 0.9020)	0.1251 (0.1098, 0.1402)	0.1109 (0.098, 0.1236)
	1095	0.8293 (0.8097, 0.8495)	0.8499 (0.8337, 0.8665)	0.1707 (0.1505, 0.1903)	0.1501 (0.1335, 0.1663)
	1420	0.7901 (0.7666, 0.8143)	0.8164 (0.7973, 0.8360)	0.2099 (0.1857, 0.2334)	0.1836 (0.164, 0.2027)
3=Q3	30	0.9746 (0.9714, 0.9779)	0.9758 (0.9727, 0.9789)	0.0254 (0.0221, 0.0286)	0.0242 (0.0211, 0.0273)
	365	0.9288 (0.9215, 0.9361)	0.9326 (0.9259, 0.9392)	0.0712 (0.0639, 0.0785)	0.0674 (0.0608, 0.0741)
	730	0.8985 (0.8886, 0.9084)	0.9046 (0.8958, 0.9134)	0.1015 (0.0916, 0.1114)	0.0954 (0.0866, 0.1042)
	1095	0.8608 (0.8478, 0.8739)	0.8701 (0.8588, 0.8815)	0.1392 (0.1261, 0.1522)	0.1299 (0.1185, 0.1412)
	1420	0.8279 (0.8123, 0.8439)	0.8403 (0.8269, 0.8540)	0.1721 (0.1561, 0.1877)	0.1597 (0.146, 0.1731)
4=Q4	30	0.9785 (0.9764, 0.9807)	0.9782 (0.9761, 0.9803)	0.0215 (0.0193, 0.0236)	0.0218 (0.0197, 0.0239)
	365	0.9396 (0.9357, 0.9434)	0.9389 (0.9352, 0.9426)	0.0604 (0.0566, 0.0643)	0.0611 (0.0574, 0.0648)
	730	0.9136 (0.9087, 0.9185)	0.9133 (0.9087, 0.9180)	0.0864 (0.0815, 0.0913)	0.0867 (0.082, 0.0913)
	1095	0.8812 (0.8749, 0.8874)	0.8815 (0.8757, 0.8874)	0.1188 (0.1126, 0.1251)	0.1185 (0.1126, 0.1243)
	1420	0.8527 (0.8451, 0.8604)	0.8540 (0.8469, 0.8611)	0.1473 (0.1396, 0.1549)	0.1460 (0.1389, 0.1531)

eTable 9. All Surgeon 1-Year HF Hospitalization Rates

MVRR Volume Quartile s		Raw CIF Estimates (95% CI) –same as in page t2 33	KM estimates (HF Incidence estimate as 1- KM Survival)	Unadjusted HF Incidence Estimates (95% CI)	Adjusted HF Incidence Estimates (95% CI)
1	30	0.0415 (0.0273, 0.0600)	0.0420 (0.0283, 0.0620)	0.0355 (0.027, 0.0440)	0.0337 (0.0258, 0.0416)
	365	0.0875 (0.0659, 0.1129)	0.0902 (0.0688, 0.1176)	0.0919 (0.0711, 0.1123)	0.0873 (0.0688, 0.1056)
	730	0.1093 (0.0842, 0.1379)	0.1141 (0.0890, 0.1458)	0.1164 (0.0904, 0.1416)	0.1108 (0.0879, 0.1331)
	1095	0.1277 (0.0994, 0.1597)	0.1352 (0.1063, 0.1712)	0.1384 (0.1079, 0.1679)	0.1320 (0.1054, 0.1579)
	1460	0.1474 (0.1153, 0.1832)	0.1584 (0.1249, 0.1998)	0.1592 (0.1244, 0.1926)	0.1518 (0.1218, 0.1808)
2	30	0.0432 (0.0331, 0.0552)	0.0436 (0.0337, 0.0562)	0.0398 (0.0334, 0.0462)	0.0367 (0.0309, 0.0424)
	365	0.1027 (0.0866, 0.1204)	0.1048 (0.0888, 0.1234)	0.1027 (0.0881, 0.1171)	0.0945 (0.0819, 0.1070)
	730	0.1238 (0.1056, 0.1434)	0.1273 (0.1091, 0.1481)	0.1298 (0.1118, 0.1475)	0.1196 (0.1042, 0.1348)
	1095	0.1470 (0.1263, 0.1691)	0.1528 (0.1318, 0.1767)	0.1542 (0.1331, 0.1748)	0.1422 (0.1244, 0.1598)
	1460	0.1712 (0.1468, 0.1971)	0.1803 (0.1550, 0.2092)	0.1770 (0.153, 0.2003)	0.1633 (0.1431, 0.1829)
3	30	0.0362 (0.0297, 0.0436)	0.0364 (0.0300, 0.0441)	0.0338 (0.0294, 0.0381)	0.0305 (0.0266, 0.0344)
	365	0.0882 (0.0778, 0.0994)	0.0899 (0.0796, 0.1016)	0.0875 (0.078, 0.0969)	0.0796 (0.0714, 0.0877)
	730	0.1112 (0.0991, 0.1240)	0.1143 (0.1021, 0.1278)	0.1109 (0.0992, 0.1224)	0.1012 (0.0912, 0.1112)
	1095	0.1282 (0.1147, 0.1425)	0.1327 (0.1189, 0.1479)	0.1319 (0.1182, 0.1454)	0.1209 (0.1092, 0.1324)
	1460	0.1411 (0.1258, 0.1573)	0.1454 (0.1299, 0.1626)	0.1518 (0.136, 0.1672)	0.1393 (0.1259, 0.1524)
4	30	0.0267 (0.0239, 0.0298)	0.0268 (0.0241, 0.0299)	0.0282 (0.0256, 0.0308)	0.0286 (0.026, 0.0311)
	365	0.0717 (0.0670, 0.0765)	0.0726 (0.0680, 0.0776)	0.0733 (0.0687, 0.0779)	0.0748 (0.0703, 0.0792)
	730	0.0909 (0.0855, 0.0965)	0.0927 (0.0872, 0.0985)	0.0931 (0.0876, 0.0986)	0.0953 (0.09, 0.1006)
	1095	0.1081 (0.1019, 0.1146)	0.1112 (0.1048, 0.1179)	0.1110 (0.1047, 0.1174)	0.1139 (0.1078, 0.1201)
	1460	0.1241 (0.1168, 0.1316)	0.1263 (0.1189, 0.1341)	0.1280 (0.1205, 0.1354)	0.1314 (0.1242, 0.1386)

eTable 10. All Surgeon 1-Year MV Reoperation Time to Event Rates

MVRR Volume Quartiles	t2	Raw CIF Estimates (95% CI) –same as seen above	KM estimates (MV REOPERATION Incidence estimate as 1-KM Survival)	Unadjusted MV REOPERATION Incidence Estimates (95% CI)	Adjusted MV REOPERATION Incidence Estimates (95% CI)
1	30	0.0035 (0.0007, 0.0118)	0.0035 (0.0009, 0.0140)	0.0011 (0.0002, 0.0020)	0.0011 (0.0002, 0.0019)
	365	0.0128 (0.0057, 0.0252)	0.0133 (0.0064, 0.0278)	0.0109 (0.004, 0.0177)	0.0107 (0.004, 0.0175)
	730	0.0175 (0.0086, 0.0319)	0.0185 (0.0096, 0.0355)	0.0163 (0.0061, 0.0263)	0.0160 (0.006, 0.0259)
	1095	0.0175 (0.0086, 0.0319)	0.0185 (0.0096, 0.0355)	0.0221 (0.0084, 0.0356)	0.0216 (0.0082, 0.0349)
	1460	0.0222 (0.0108, 0.0408)	0.0244 (0.0123, 0.0481)	0.0255 (0.0097, 0.0410)	0.0249 (0.0094, 0.0400)
2	30	0.0023 (0.0007, 0.0065)	0.0024 (0.0008, 0.0073)	0.0012 (0.0005, 0.0019)	0.0012 (0.0004, 0.0019)
	365	0.0107 (0.0060, 0.0179)	0.0111 (0.0064, 0.0190)	0.0119 (0.0071, 0.0167)	0.0115 (0.0068, 0.0162)
	730	0.0182 (0.0114, 0.0275)	0.0192 (0.0123, 0.0298)	0.0178 (0.0107, 0.0248)	0.0171 (0.0103, 0.0239)
	1095	0.0219 (0.0142, 0.0323)	0.0234 (0.0155, 0.0353)	0.0242 (0.0147, 0.0336)	0.0231 (0.014, 0.0322)
	1460	0.0264 (0.0170, 0.0391)	0.0256 (0.0169, 0.0386)	0.0279 (0.0169, 0.0387)	0.0266 (0.0161, 0.0370)
3	30	0.0000 (0.0000, 0.0000)	0.0000 (0.0000, 0.0000)	0.0010 (0.0004, 0.0016)	0.0010 (0.0004, 0.0016)
	365	0.0090 (0.0059, 0.0133)	0.0093 (0.0062, 0.0141)	0.0099 (0.0067, 0.0130)	0.0099 (0.0068, 0.0131)
	730	0.0136 (0.0095, 0.0191)	0.0143 (0.0101, 0.0203)	0.0148 (0.0102, 0.0192)	0.0148 (0.0102, 0.0193)
	1095	0.0191 (0.0137, 0.0259)	0.0204 (0.0148, 0.0281)	0.0201 (0.014, 0.0261)	0.0200 (0.0139, 0.0260)
	1460	0.0211 (0.0152, 0.0285)	0.0226 (0.0164, 0.0311)	0.0231 (0.0161, 0.0301)	0.0230 (0.016, 0.0299)
4	30	0.0009 (0.0005, 0.0016)	0.0009 (0.0005, 0.0017)	0.0009 (0.0005, 0.0014)	0.0010 (0.0005, 0.0014)
	365	0.0092 (0.0075, 0.0111)	0.0094 (0.0077, 0.0115)	0.0093 (0.0076, 0.0110)	0.0095 (0.0077, 0.0112)
	730	0.0133 (0.0112, 0.0157)	0.0138 (0.0116, 0.0164)	0.0139 (0.0117, 0.0162)	0.0141 (0.0118, 0.0164)
	1095	0.0182 (0.0155, 0.0213)	0.0192 (0.0164, 0.0226)	0.0190 (0.016, 0.0219)	0.0191 (0.0161, 0.0221)
	1460	0.0206 (0.0175, 0.0241)	0.0211 (0.0179, 0.0248)	0.0219 (0.0184, 0.0253)	0.0219 (0.0184, 0.0254)

eTable 11. Experienced Surgeons 1-Year Mortality Time to Event Rates

MVRR Volume Quartiles	t2	Unadjusted Survival Estimates (95% CI)	Adjusted Survival Estimates (95% CI)	Unadjusted Failure Estimates (95% CI)	Adjusted Failure Estimates (95% CI)
1=Q1	30	0.9631 (0.9558, 0.9703)	0.9653 (0.9586, 0.9720)	0.0369 (0.0297, 0.0442)	0.0347 (0.028, 0.0414)
	365	0.8981 (0.8804, 0.9160)	0.9058 (0.8904, 0.9216)	0.1019 (0.084, 0.1196)	0.0942 (0.0784, 0.1096)
	730	0.8547 (0.8307, 0.8795)	0.8675 (0.847, 0.8885)	0.1453 (0.1205, 0.1693)	0.1325 (0.1115, 0.1530)
	1095	0.8016 (0.7702, 0.8342)	0.8211 (0.7951, 0.8480)	0.1984 (0.1658, 0.2298)	0.1789 (0.152, 0.2049)
	1420	0.7564 (0.7193, 0.7955)	0.7822 (0.7521, 0.8136)	0.2436 (0.2045, 0.2807)	0.2178 (0.1864, 0.2479)
2=Q2	30	0.9692 (0.9645, 0.9739)	0.9715 (0.9672, 0.9758)	0.0308 (0.0261, 0.0355)	0.0285 (0.0242, 0.0328)
	365	0.9144 (0.9034, 0.9256)	0.9218 (0.9121, 0.9316)	0.0856 (0.0744, 0.0966)	0.0782 (0.0684, 0.0879)
	730	0.8776 (0.8626, 0.8929)	0.8892 (0.8763, 0.9023)	0.1224 (0.1071, 0.1374)	0.1108 (0.0977, 0.1237)
	1095	0.8319 (0.8122, 0.8522)	0.8491 (0.8325, 0.8660)	0.1681 (0.1478, 0.1878)	0.1509 (0.134, 0.1675)
	1420	0.7928 (0.7692, 0.8171)	0.8150 (0.7956, 0.8350)	0.2072 (0.1829, 0.2308)	0.1850 (0.165, 0.2044)
3=Q3	30	0.9759 (0.9727, 0.9790)	0.9770 (0.974, 0.9800)	0.0241 (0.021, 0.0273)	0.0230 (0.02, 0.0260)
	365	0.9326 (0.9255, 0.9397)	0.9360 (0.9296, 0.9425)	0.0674 (0.0603, 0.0745)	0.0640 (0.0575, 0.0704)
	730	0.9031 (0.8935, 0.9128)	0.9087 (0.9001, 0.9174)	0.0969 (0.0872, 0.1065)	0.0913 (0.0826, 0.0999)
	1095	0.8662 (0.8535, 0.8791)	0.8746 (0.8635, 0.8859)	0.1338 (0.1209, 0.1465)	0.1254 (0.1141, 0.1365)
	1420	0.8342 (0.8187, 0.8499)	0.8454 (0.832, 0.8589)	0.1658 (0.1501, 0.1813)	0.1546 (0.1411, 0.1680)
4=Q4	30	0.9785 (0.9763, 0.9807)	0.9782 (0.9761, 0.9804)	0.0215 (0.0193, 0.0237)	0.0218 (0.0196, 0.0239)
	365	0.9399 (0.9359, 0.9439)	0.9394 (0.9356, 0.9433)	0.0601 (0.0561, 0.0641)	0.0606 (0.0567, 0.0644)
	730	0.9135 (0.9084, 0.9186)	0.9134 (0.9085, 0.9182)	0.0865 (0.0814, 0.0916)	0.0866 (0.0818, 0.0915)
	1095	0.8803 (0.8737, 0.8868)	0.8809 (0.8747, 0.8870)	0.1197 (0.1132, 0.1263)	0.1191 (0.113, 0.1253)
	1420	0.8513 (0.8434, 0.8594)	0.8528 (0.8454, 0.8603)	0.1487 (0.1406, 0.1566)	0.1472 (0.1397, 0.1546)

eTable 12. Experienced Surgeon 1-Year HF Hospitalization Time to Event Rates

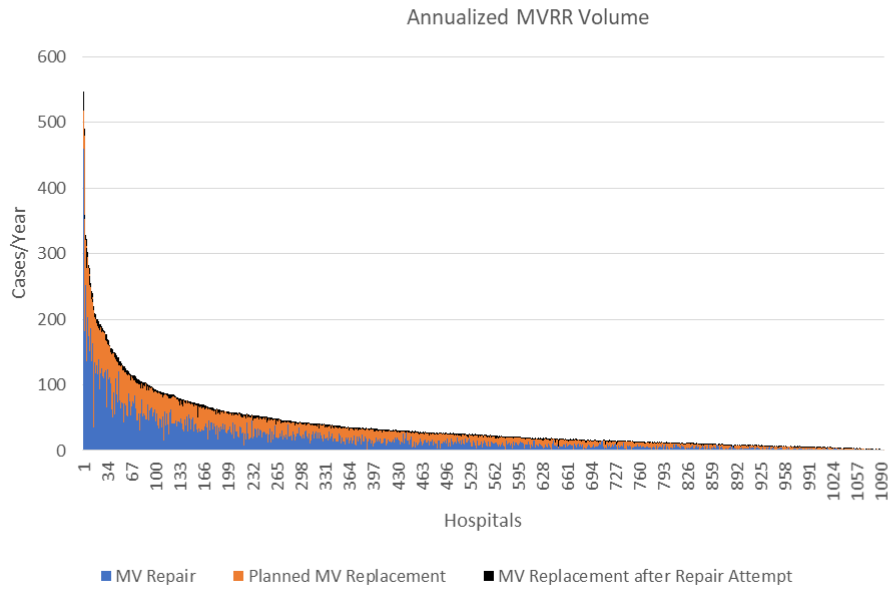
MVRV Volume Quartiles	t2	REPAIRS		REPLACEMENTS	
		Unadjusted Risk Estimates (95% CI)	Adjusted Risk Estimates (95% CI)	Unadjusted Risk Estimates (95% CI)	Adjusted Risk Estimates (95% CI)
1=Q1	30	0.0314 (0.0208, 0.0419)	0.0288 (0.0192, 0.0382)	0.0432 (0.0279, 0.0582)	0.0469 (0.0306, 0.0630)
	365	0.0835 (0.0568, 0.1095)	0.0764 (0.0533, 0.0988)	0.1114 (0.0749, 0.1464)	0.1214 (0.0837, 0.1576)
	730	0.1078 (0.0737, 0.1406)	0.0985 (0.0697, 0.1265)	0.1391 (0.0943, 0.1817)	0.1523 (0.1064, 0.1958)
	1095	0.1292 (0.0888, 0.1678)	0.1179 (0.0841, 0.1504)	0.1634 (0.1114, 0.2124)	0.1800 (0.1271, 0.2297)
	1420	0.1506 (0.1039, 0.1948)	0.1370 (0.0985, 0.1738)	0.1845 (0.1261, 0.2389)	0.2040 (0.145, 0.2589)
2=Q2	30	0.0298 (0.0228, 0.0367)	0.0262 (0.0202, 0.0322)	0.0461 (0.0349, 0.0572)	0.0501 (0.0381, 0.0620)
	365	0.0794 (0.0625, 0.0959)	0.0700 (0.0559, 0.0839)	0.1186 (0.0937, 0.1428)	0.1290 (0.1032, 0.1541)
	730	0.1025 (0.0811, 0.1234)	0.0906 (0.0729, 0.1079)	0.1480 (0.1177, 0.1772)	0.1615 (0.1305, 0.1914)
	1095	0.1229 (0.0976, 0.1475)	0.1086 (0.0879, 0.1288)	0.1737 (0.1388, 0.2072)	0.1906 (0.155, 0.2246)
	1420	0.1434 (0.1141, 0.1717)	0.1264 (0.1027, 0.1494)	0.1959 (0.1567, 0.2332)	0.2157 (0.1761, 0.2533)
3=Q3	30	0.0294 (0.0244, 0.0343)	0.0260 (0.0217, 0.0304)	0.0473 (0.0378, 0.0566)	0.0513 (0.0413, 0.0611)
	365	0.0783 (0.0674, 0.0891)	0.0695 (0.0602, 0.0787)	0.1214 (0.1019, 0.1406)	0.1317 (0.1117, 0.1513)
	730	0.1012 (0.0875, 0.1147)	0.0900 (0.0785, 0.1013)	0.1515 (0.1278, 0.1745)	0.1647 (0.1409, 0.1880)
	1095	0.1214 (0.1052, 0.1373)	0.1079 (0.0944, 0.1212)	0.1777 (0.1505, 0.2042)	0.1943 (0.1668, 0.2208)
	1420	0.1416 (0.1227, 0.1600)	0.1256 (0.1101, 0.1408)	0.2004 (0.1696, 0.2300)	0.2197 (0.1889, 0.2494)
4=Q4	30	0.0222 (0.0195, 0.0249)	0.0223 (0.0196, 0.0250)	0.0486 (0.041, 0.0562)	0.0458 (0.0388, 0.0529)
	365	0.0595 (0.0546, 0.0643)	0.0601 (0.0554, 0.0647)	0.1249 (0.1112, 0.1383)	0.1188 (0.1063, 0.1312)
	730	0.0771 (0.0712, 0.0829)	0.0780 (0.0724, 0.0836)	0.1557 (0.1395, 0.1715)	0.1491 (0.1343, 0.1637)
	1095	0.0927 (0.0858, 0.0996)	0.0939 (0.0873, 0.1004)	0.1826 (0.164, 0.2007)	0.1764 (0.1592, 0.1932)
	1420	0.1084 (0.1002, 0.1166)	0.1096 (0.1018, 0.1173)	0.2058 (0.1845, 0.2265)	0.2000 (0.1801, 0.2194)

eTable 13. Experienced Surgeons 1-Year MV Reoperation Time to Event Rates

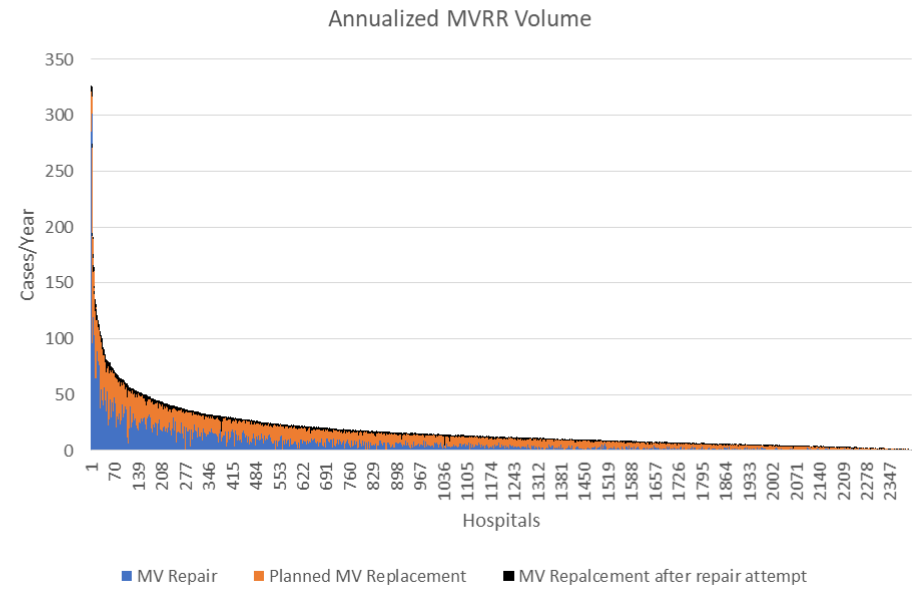
MVRR Volume Quartiles	t2	Raw CIF Estimates (95% CI) –same as seem above	KM estimates (MV REOPERATION Incidence estimate as 1-KM Survival)	Unadjusted MV REOPERATION Incidence Estimates (95% CI)	Adjusted MV REOPERATION Incidence Estimates (95% CI)
1	30	0.0037 (0.0008, 0.0125)	0.0037 (0.0009, 0.0149)	0.0013 (0.0003, 0.0022)	0.0013 (0.0003, 0.0022)
	365	0.0112 (0.0047, 0.0232)	0.0115 (0.0052, 0.0254)	0.0125 (0.005, 0.0199)	0.0124 (0.0049, 0.0198)
	730	0.0160 (0.0075, 0.0302)	0.0169 (0.0084, 0.0337)	0.0188 (0.0076, 0.0299)	0.0186 (0.0075, 0.0296)
	1095	0.0216 (0.0110, 0.0384)	0.0234 (0.0124, 0.0439)	0.0259 (0.0106, 0.0409)	0.0254 (0.0103, 0.0402)
	1460	0.0266 (0.0135, 0.0473)	0.0297 (0.0155, 0.0563)	0.0297 (0.0122, 0.0468)	0.0291 (0.0119, 0.0460)
2	30	0.0024 (0.0007, 0.0066)	0.0024 (0.0008, 0.0074)	0.0012 (0.0004, 0.0019)	0.0011 (0.0004, 0.0018)
	365	0.0110 (0.0062, 0.0183)	0.0114 (0.0066, 0.0196)	0.0115 (0.0067, 0.0162)	0.0111 (0.0065, 0.0157)
	730	0.0186 (0.0117, 0.0282)	0.0197 (0.0127, 0.0305)	0.0173 (0.0103, 0.0243)	0.0167 (0.0099, 0.0235)
	1095	0.0212 (0.0136, 0.0316)	0.0227 (0.0148, 0.0345)	0.0238 (0.0142, 0.0332)	0.0228 (0.0136, 0.0319)
	1460	0.0257 (0.0164, 0.0384)	0.0249 (0.0163, 0.0379)	0.0273 (0.0163, 0.0381)	0.0261 (0.0156, 0.0365)
3	30	0.0004 (0.0000, 0.0020)	0.0004 (0.0001, 0.0025)	0.0010 (0.0004, 0.0016)	0.0010 (0.0004, 0.0016)
	365	0.0102 (0.0068, 0.0147)	0.0105 (0.0072, 0.0155)	0.0099 (0.0068, 0.0130)	0.0098 (0.0067, 0.0129)
	730	0.0143 (0.0101, 0.0198)	0.0150 (0.0107, 0.0210)	0.0149 (0.0104, 0.0194)	0.0147 (0.0102, 0.0192)
	1095	0.0189 (0.0137, 0.0256)	0.0200 (0.0146, 0.0274)	0.0205 (0.0144, 0.0266)	0.0201 (0.0141, 0.0261)
	1460	0.0209 (0.0151, 0.0281)	0.0222 (0.0162, 0.0304)	0.0235 (0.0165, 0.0305)	0.0230 (0.0161, 0.0299)
4	30	0.0008 (0.0004, 0.0015)	0.0008 (0.0004, 0.0016)	0.0009 (0.0005, 0.0014)	0.0009 (0.0005, 0.0014)
	365	0.0088 (0.0072, 0.0109)	0.0091 (0.0074, 0.0112)	0.0092 (0.0074, 0.0110)	0.0093 (0.0075, 0.0111)
	730	0.0132 (0.0110, 0.0157)	0.0137 (0.0115, 0.0164)	0.0139 (0.0115, 0.0163)	0.0140 (0.0116, 0.0165)
	1095	0.0185 (0.0156, 0.0217)	0.0195 (0.0165, 0.0231)	0.0191 (0.016, 0.0222)	0.0192 (0.016, 0.0223)
	1460	0.0207 (0.0175, 0.0245)	0.0212 (0.0179, 0.0252)	0.0219 (0.0183, 0.0255)	0.0219 (0.0183, 0.0256)

eFigure 1. Hospital- and Surgeon-Level Annualized Mitral Valve Repair and Replacement (MVRR) Volume

A.

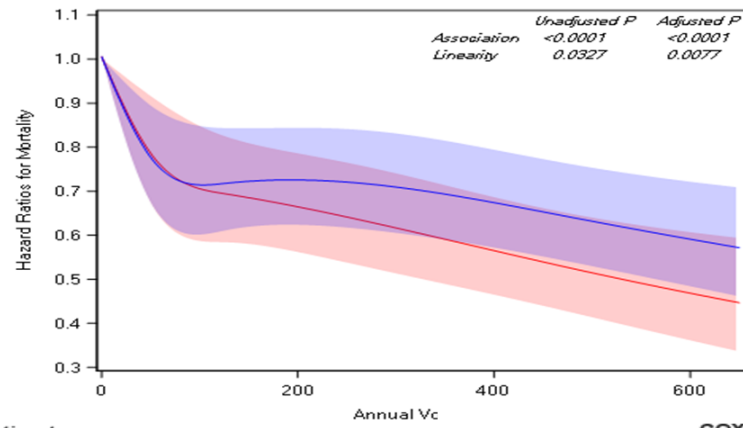


B.

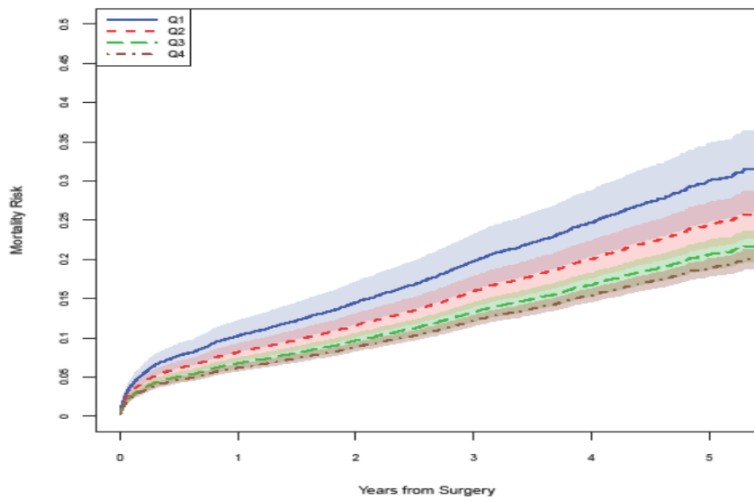


A. Hospital Level. MV repair (blue), planned MV replacement (orange), and MV replacement after MV repair attempt (black). B. Surgeon level MV repair (blue), planned MV replacement (orange), and MV replacement after MV repair attempt (grey).

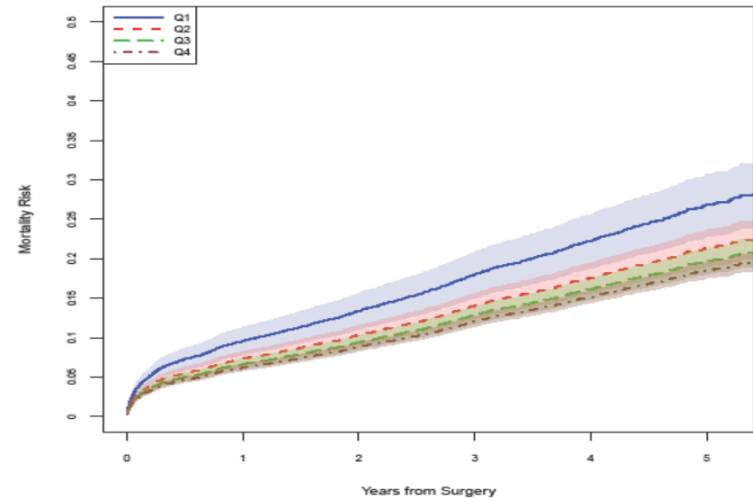
eFigure 2. Hospital-Level Linked CMS 1-Year Risk-Adjusted Mortality



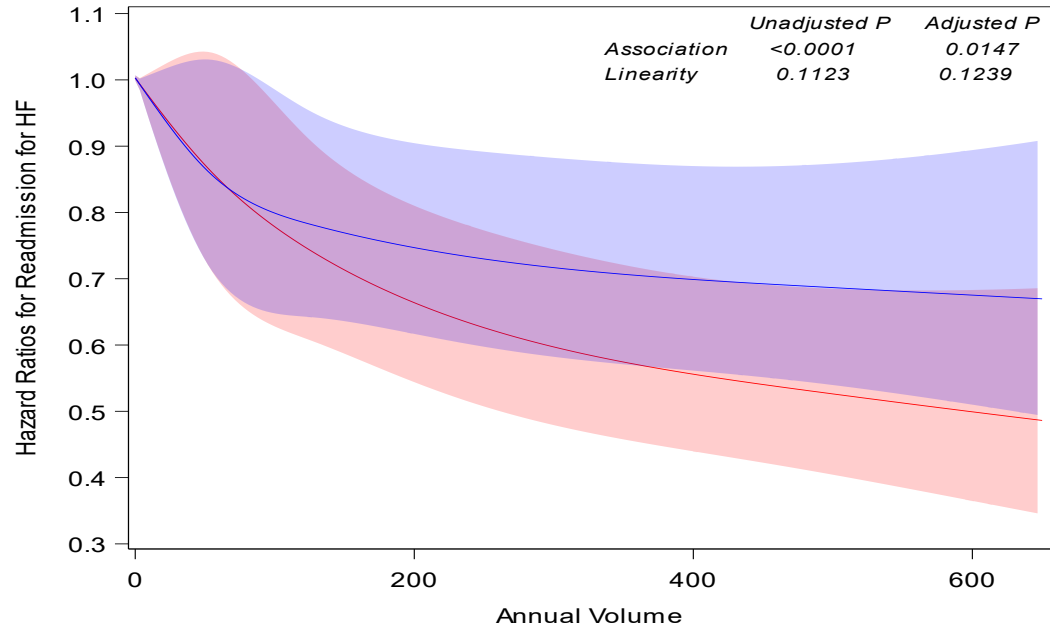
COX Mortality Risk Estimates Unadjusted



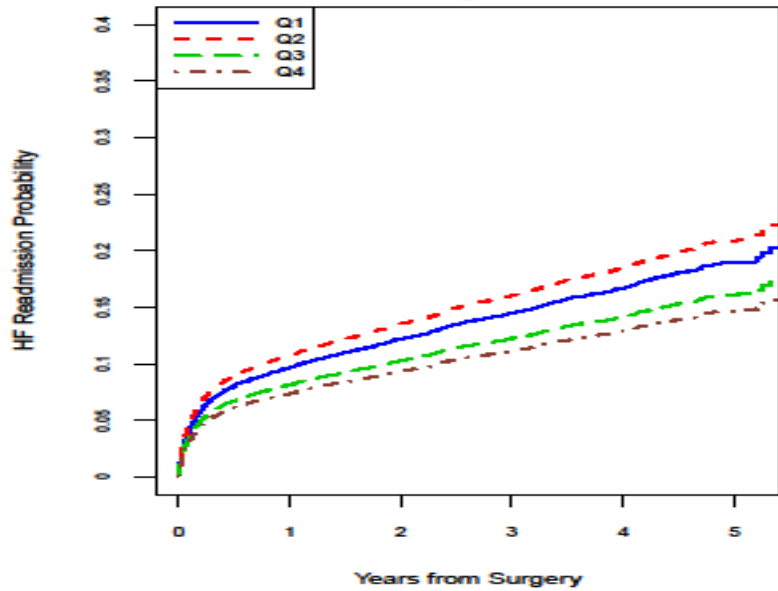
COX Mortality Risk Estimates Adjusted



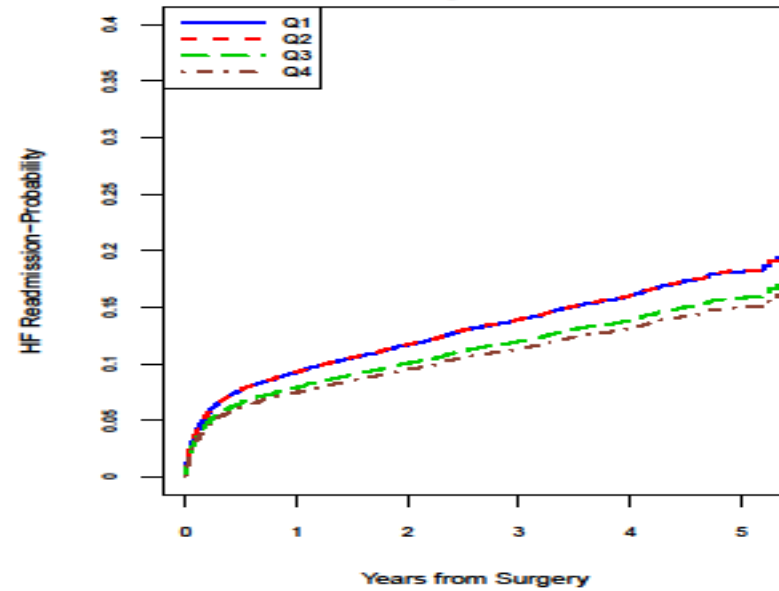
eFigure 3. Hospital-Level Linked CMS 1-Year HF Hospitalization



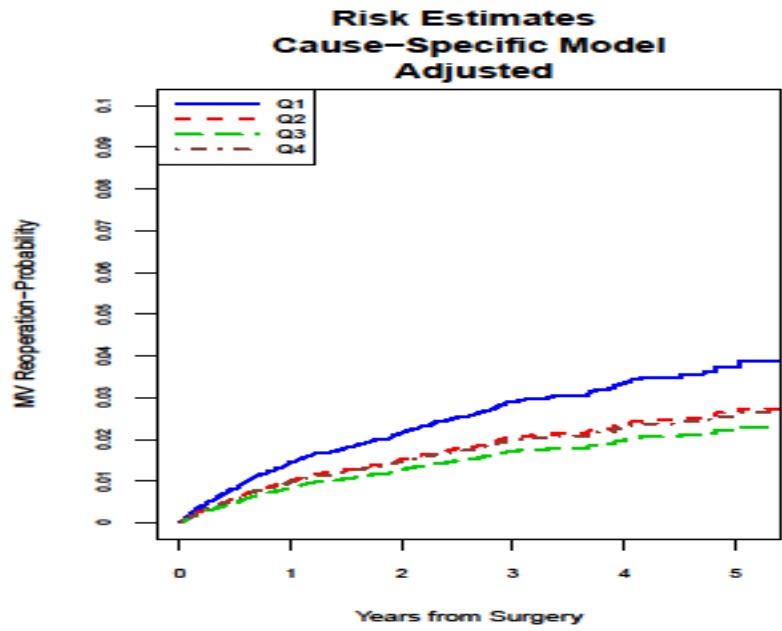
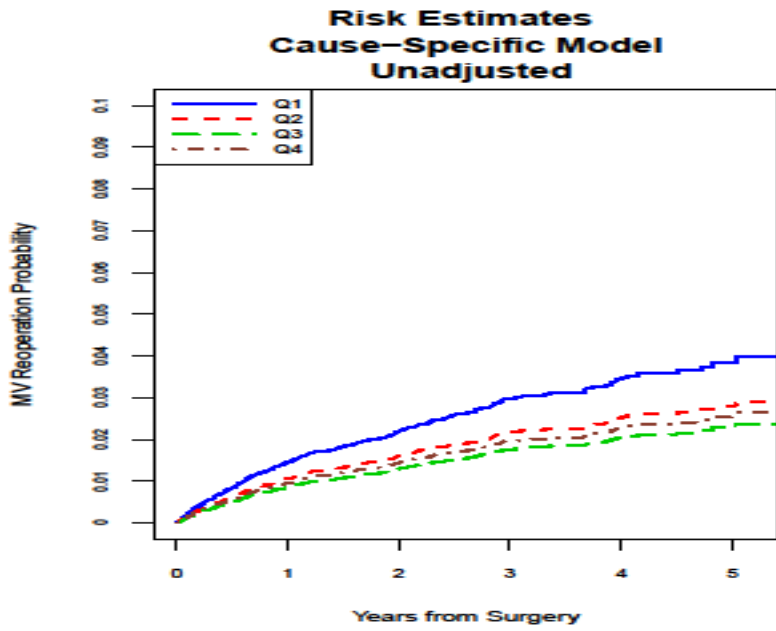
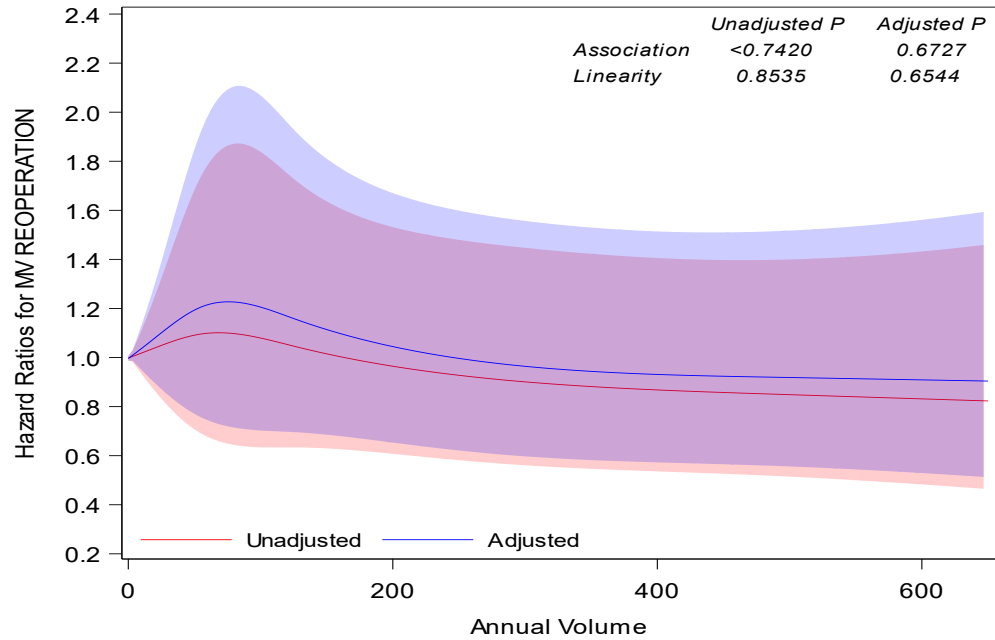
**Risk Estimates
Cause-Specific Model
Unadjusted**



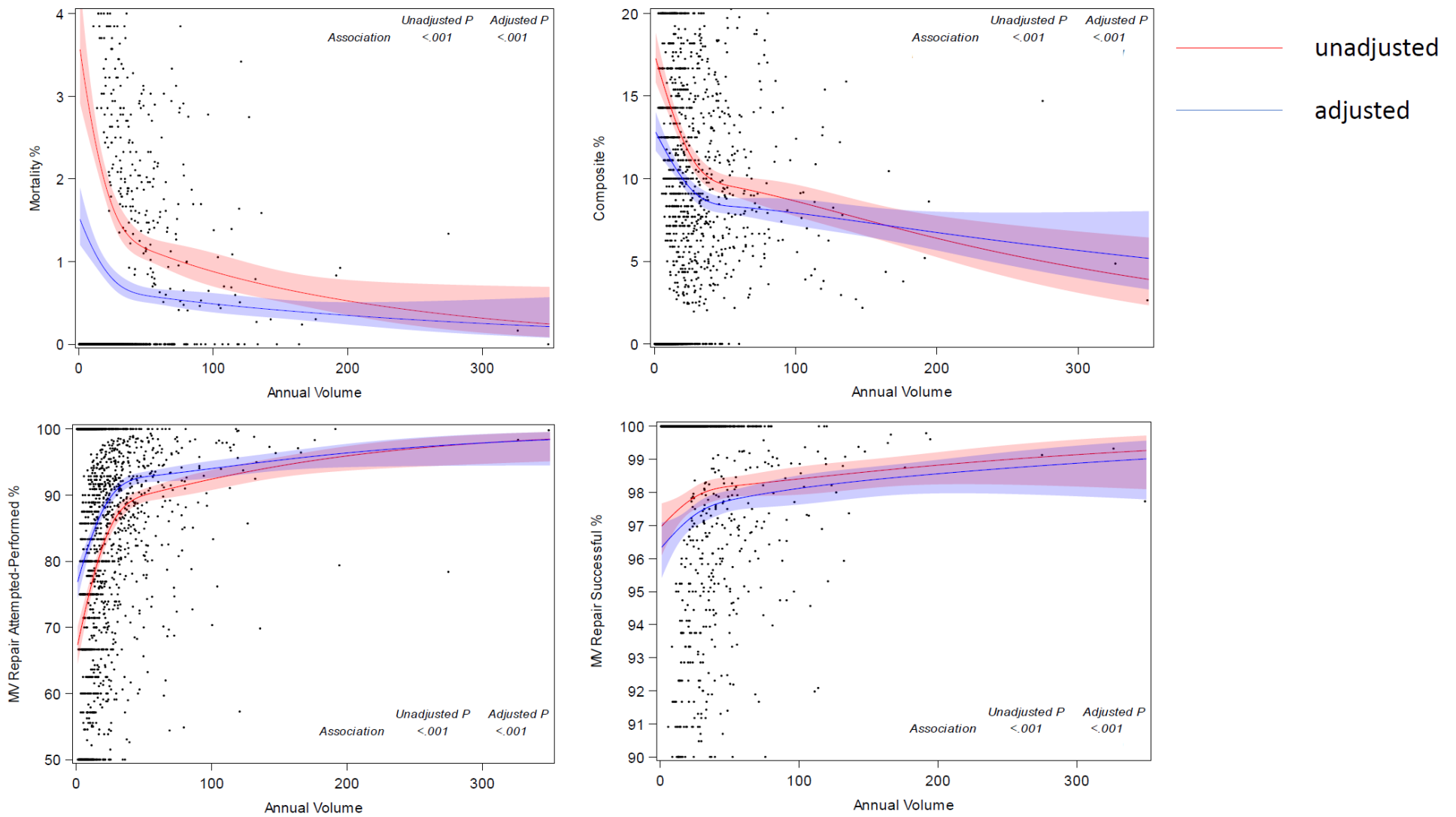
**Risk Estimates
Cause-Specific Model
Adjusted**



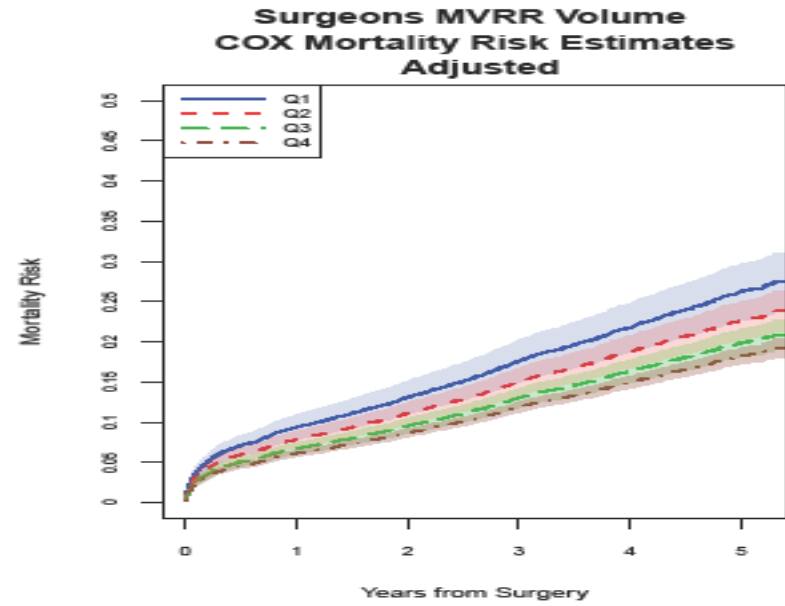
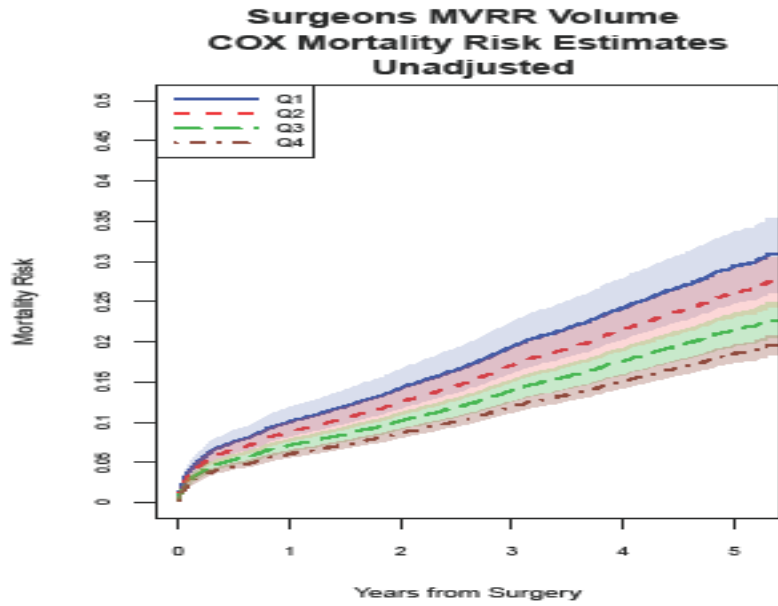
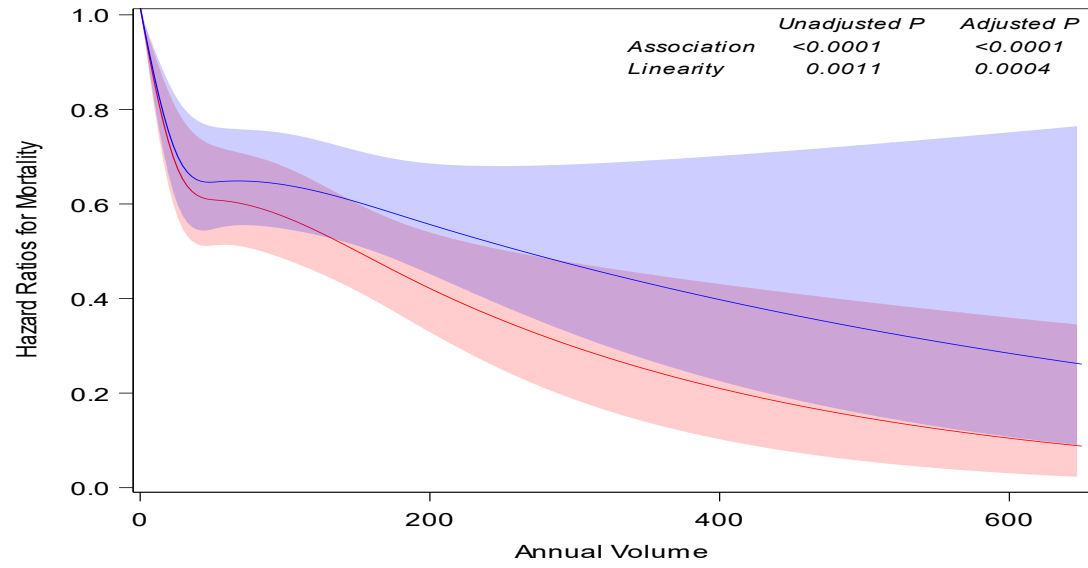
eFigure 4. Hospital-Level Linked CMS 1-Year MV Reoperation



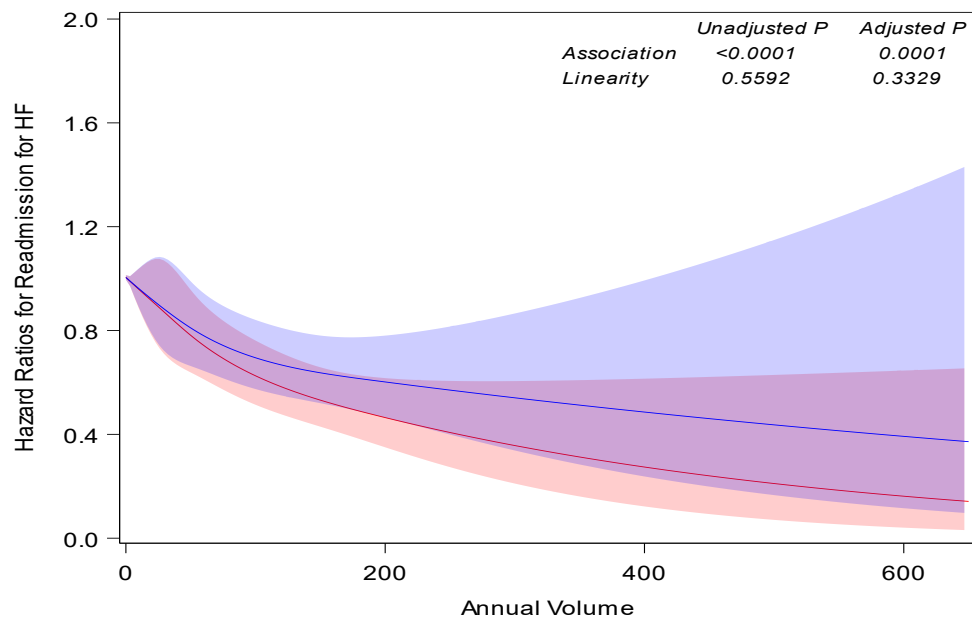
eFigure 5. Experienced Surgeon Sensitivity Analysis: 30-Day Volume-Outcome Association for Mortality, Composite Major Morbidity Plus Mortality, Attempted MV Repair Rate, Successful MV Repair Rate



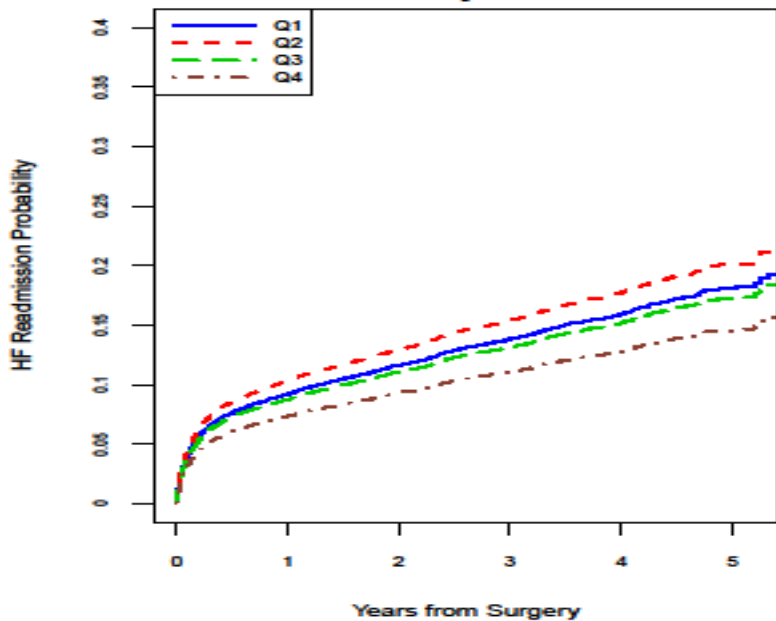
eFigure 6. All Surgeon-Linked CMS 1-Year Risk-Adjusted Mortality



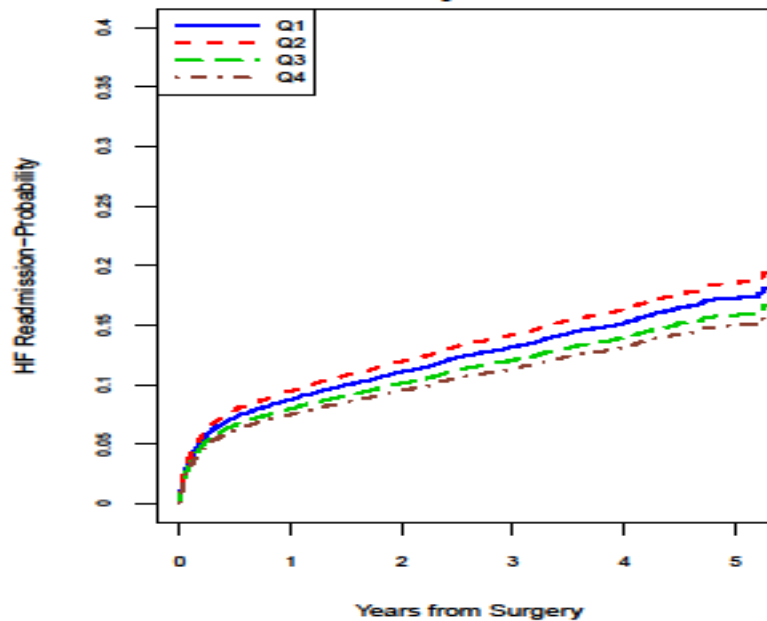
eFigure 7. All Surgeon-Linked CMS 1-Year HF Hospitalization



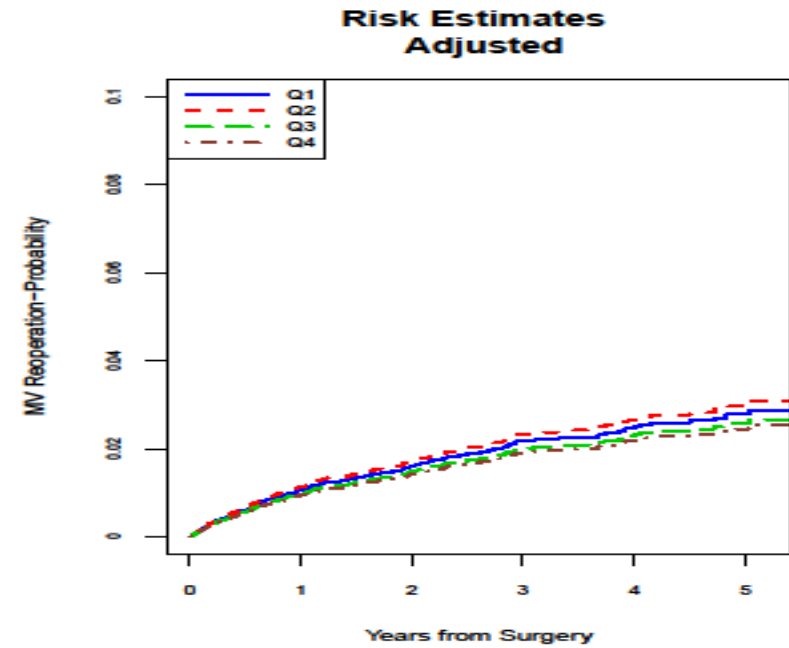
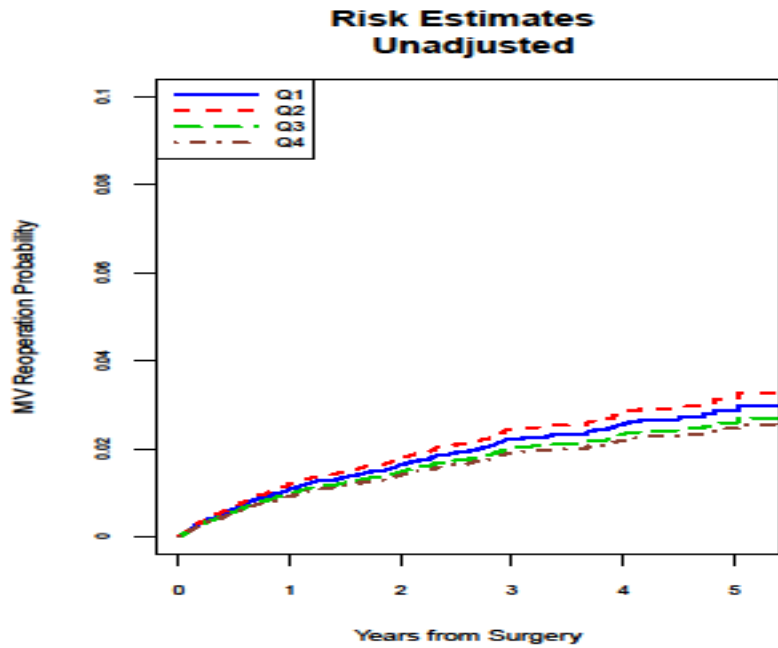
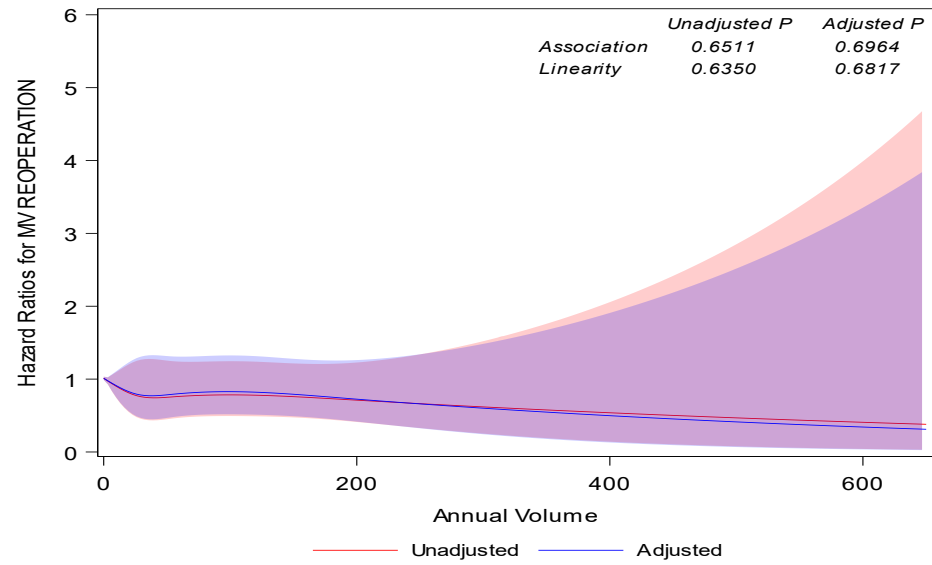
**Risk Estimates
Cause-Specific Model
Unadjusted**



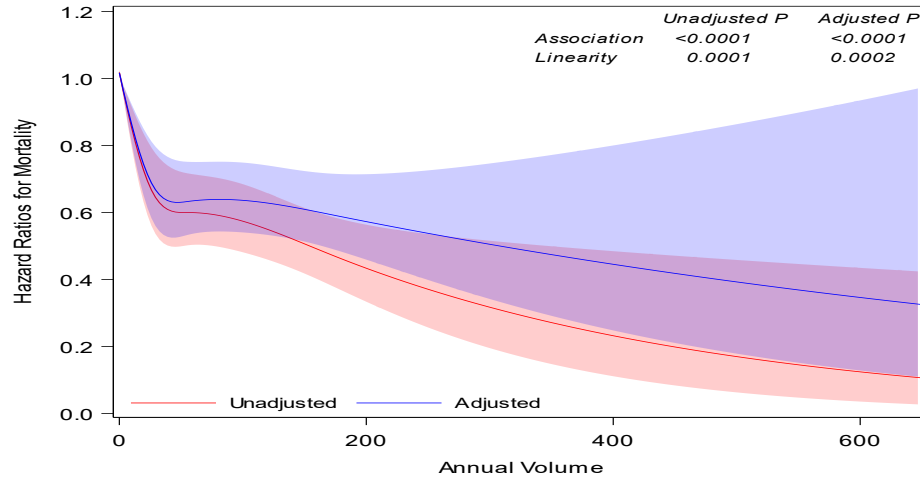
**Risk Estimates
Cause-Specific Model
Adjusted**



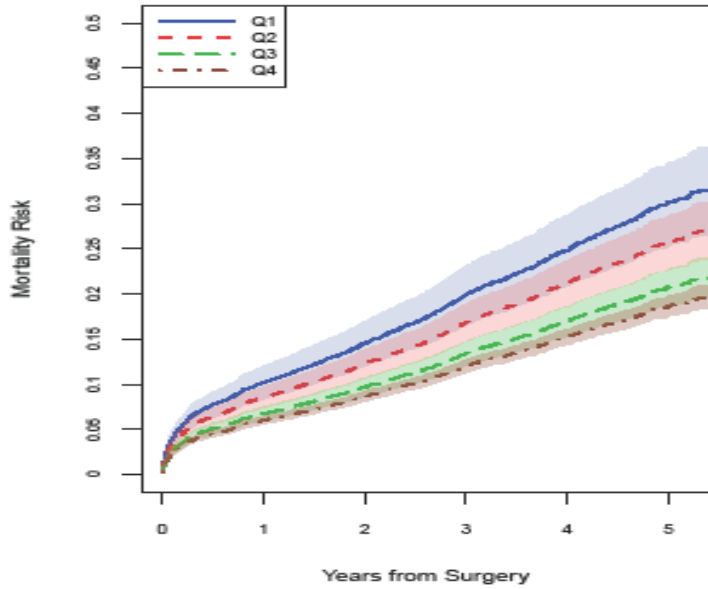
eFigure 8. All Surgeon-Linked CMS 1-Year MV Reoperation



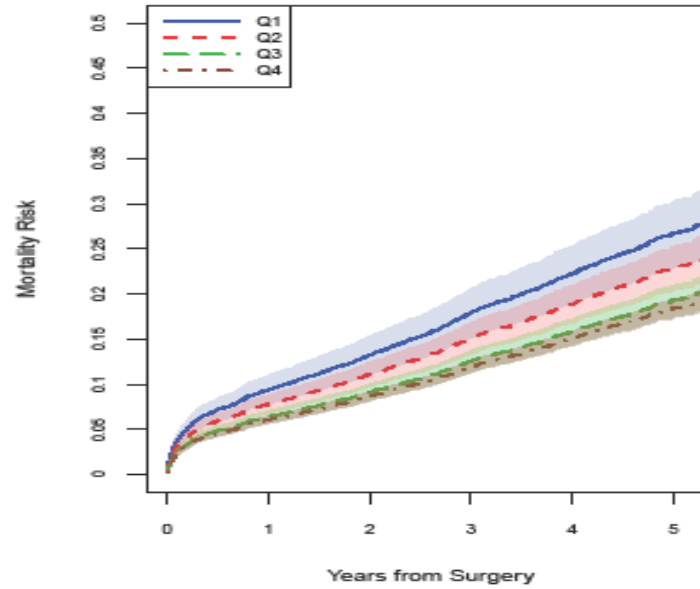
eFigure 9. Experienced Surgeon-Linked CMS 1-Year Risk-Adjusted Mortality



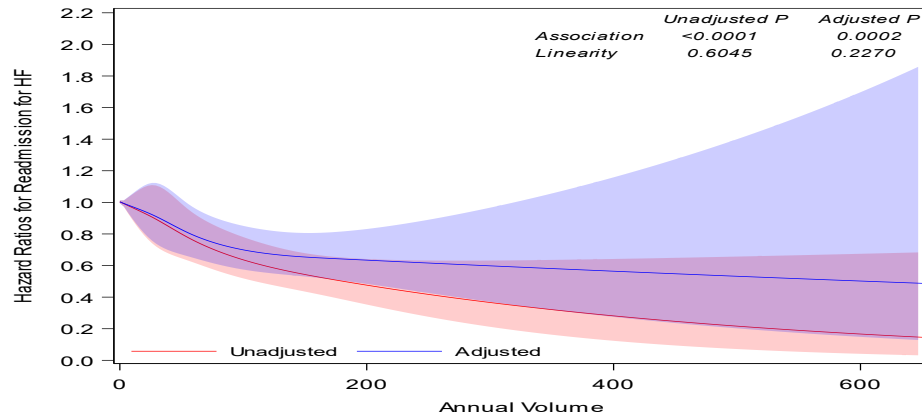
**Experienced Surgeons MVRR Volume
COX Mortality Risk Estimates
Unadjusted**



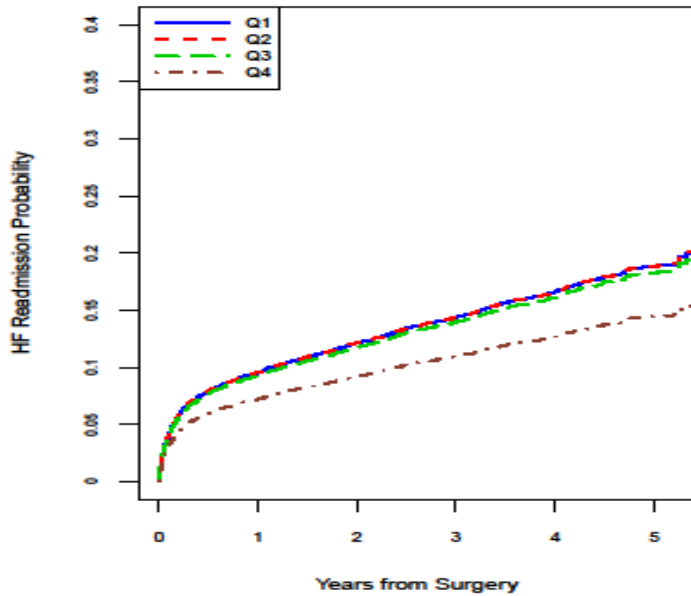
**Experienced Surgeons MVRR Volume
COX Mortality Risk Estimates
Adjusted**



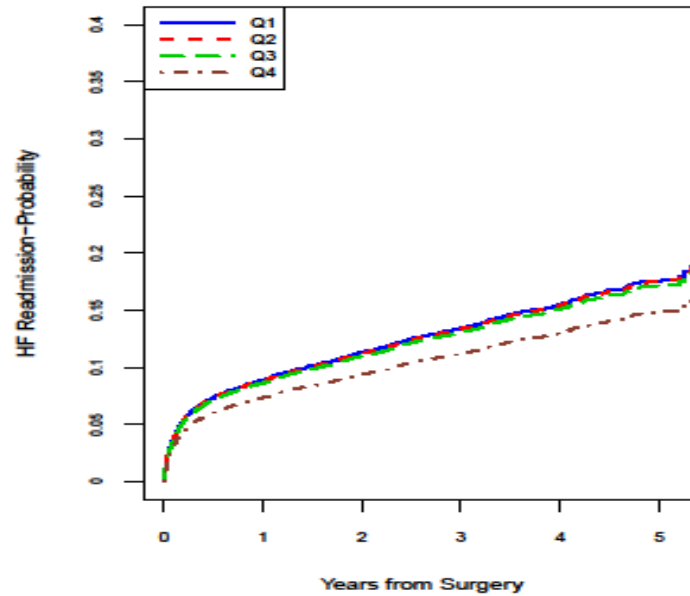
eFigure 10. Experienced Surgeon-Linked CMS 1-Year HF Hospitalization



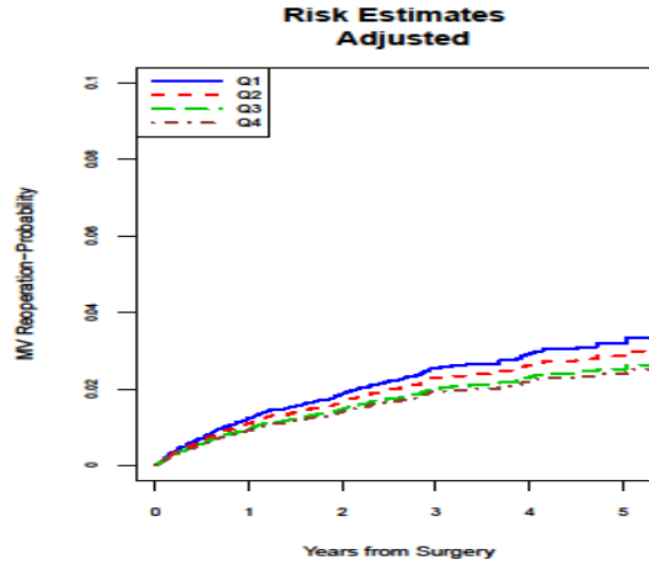
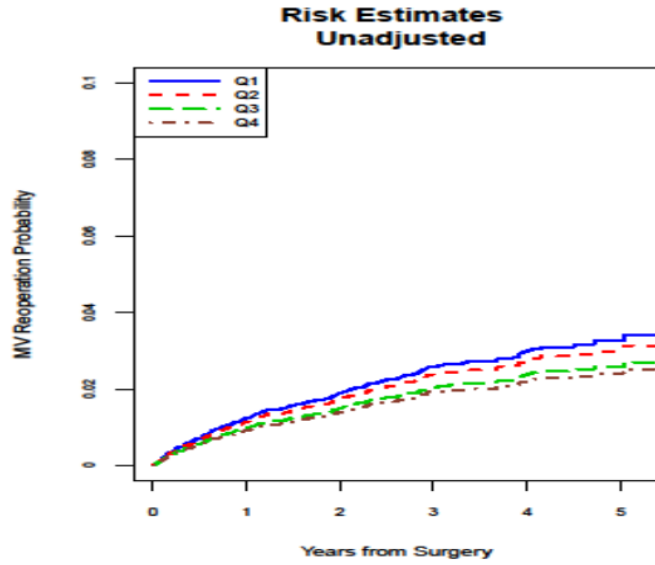
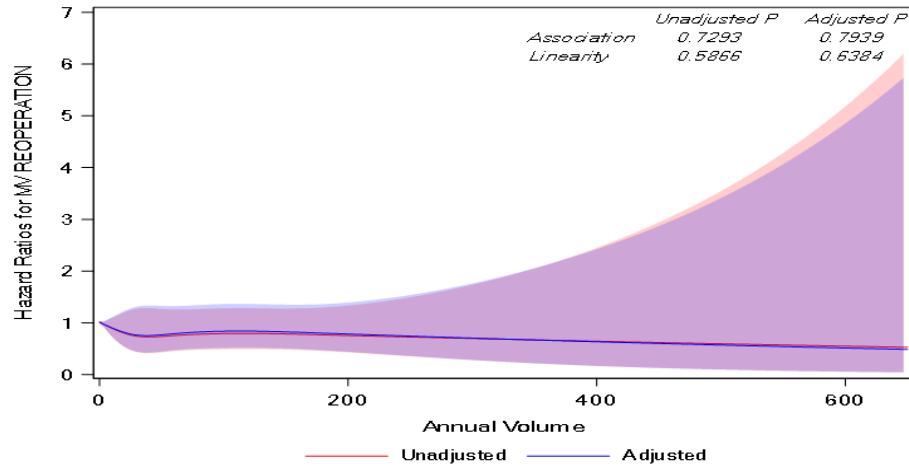
Risk Estimates Unadjusted



Risk Estimates Adjusted



eFigure 11. Experienced Surgeon-Linked CMS 1-Year MV Reoperation



eResults. Surgeons With 3 Years of Experience

Sensitivity Analysis of Surgeons with 3 years of Experience

For the surgeon-level analysis, we pre-specified a sensitivity analysis to account for the operator learning curve by excluding surgeons with fewer than three years MV surgical experience documented in STS ACSD, and then repeating the surgeon level analysis as outlined in the Methods.

Outcomes of Surgeons with at least 3 years' Experience

As a pre-specified sensitivity analysis, the surgeon level analysis was repeated for surgeons with at least 3 years' of experience. This sub-analysis included 94.0% of the total cohort of operations (51,975/55,311) performed by 89.3% of the total cohort of surgeons (2,152/2,410). The median experienced surgeon MVRR volume was 13 (IQR 7-24) and the median experienced surgeon MV repair volume was 6 (IQR 2-13). These findings were not substantially different to the overall cohort.

For experienced surgeon level 30-day outcomes, there remained a significant, nonlinear association between 30-day mortality, 30-day composite, 30-day MV repair attempted, and 30-day successful MV repair (adjusted and unadjusted) and annualized experienced surgeon MVRR surgical volume (Supplemental Figure S5 and Supplemental Table S7). There was no interaction by surgery type (repair or replacement) between the association of annualized experienced surgeon MVRR volume and any of these outcomes.

Similarly, for experienced surgeon level 1-year outcomes, there remained higher adjusted mortality in the lowest volume quartile centers (9.42%, 95% CI 7.84%-10.96%) vs. the highest volume quartile centers (6.06%, 95% CI 5.67%-6.44%) (HR 1.62, 95% CI 1.34 – 1.97) (Supplemental Figure S9 and Supplemental Table S11). There was no significant difference in 1-year HF hospitalization or MV reoperation rates between the lowest volume quartile and the highest volume quartile (Supplemental Figures S10 and S11 and Supplemental Tables S12 and S13). There was no interaction by surgery type (repair or replacement) between the association of annualized experienced surgeon MVRR volume and any of these outcomes. These findings were not substantially different than the overall surgeon outcomes.