

APPENDIX

Supplemental Table 1. Codes Used for Analysis

Measure	Codes/reference
Video-assisted thoracic surgery (VATS) lobectomy	32.41; 0BTC4ZZ; 0BTD4ZZ; 0BTF4ZZ; 0BTG4ZZ; 0BTH4ZZ; 0BTJ4ZZ; 0BTK4ZZ; 0BTL4ZZ; 0BTM4ZZ
Charlson & Elixhauser Comorbidity Indices & constituent comorbidities	See: Quan H, Sundararajan V, Halfon P, et al Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. Med Care. 2005;43:1130-9.
Wedge resection	32.20; 32.28; 32.29; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ; 0B5C0ZZ
Segmentectomy resection	32.3; 32.39; 0BTH0ZZ
Robotic assistance	17.41; 17.42; 17.43; 17.44; 17.45; 8E090CZ; 8E0W0CZ; 8E0X0CZ; 8E0Y0CZ; 8E0W4CZ; 8E093CZ; 8E0W3CZ; 8E0X3CZ; 8E0Y3CZ; 8E094CZ; 8E098CZ; 8E0W8CZ; 8E0X4CZ; 8E0Y4CZ; 8E0W4CZ; 8E0X4CZ; 8E0Y4CZ
Bleeding	459.0; 285.1; 998.11; 998.11; 998.12; 998.13; R58; D62; J95.62; J95.831; J95.861; J95.61; J95.830; J95.860; J95.863; J95.862; I97.418; I97.618; I97.638; I97.42; I97.620; I97.621; I97.622
Transfusions	99.00; 99.01; 99.02; 99.03; 99.04; 99.05; 99.07; 99.08; 99.09; 30233H0; 30233N0; 30243H0; 30243N0; 30253H0; 30253N0; 30263H0; 30263N0; 30233H1; 30243H1; 30253H1; 30263H1; 30233H0; 30233N0; 30233W0; 30243H0; 30243N0; 30243W0; 30253H0; 30253N0; 30253W0; 30263H0; 30263N0; 30263W0; 30233H1; 30243H1; 30253H1; 30263H1; 30233N1; 30233P1; 30243N1; 30243P1; 30253N1; 30253P1; 30263N1; 30263P1; 30233R1; 30243R1; 30253R1; 30263R1; 30233T1; 30233V1; 30233W1; 30243T1; 30243V1; 30243W1; 30253T1; 30253V1; 30253W1; 30263T1;

	30263V1; 30263W1; 30233J1; 30233K1; 30233L1; 30233M1; 30243J1; 30243K1; 30243L1; 30243M1; 30253J1; 30253K1; 30253L1; 30253M1; 30263J1; 30263K1; 30263L1; 30263M1; 3E033GC; 3E043GC; 3E053GC; 3E063GC; 30233Q1; 30243Q1; 30253Q1; 30263Q1; 36430; 86890; 86891; 86985; P9010; P9011; P9012; P9016; P9017; P9021; P9022; P9023; P9038; P9039; P9040; P9043; P9044; P9048; P9051; P9054; P9056; P9057; P9058; P9059; P9060
Acute post hemorrhagic anemia	285.1; D62
Air leak	512.2; 512.84; J95.812; J93.82
Pneumothorax	512.1; 512.89; J95.811; J93.83; J93.9
Pneumonia	481; 482.0; 482.1; 482.2; 482.39; 482.41; 482.42; 482.81; 482.89; 482.9; 483.0; 483.8; 485'; 486; 507.0; 507.8; 997.32; J13; J181; J150; J151; J14; J154; J15211; J15212; J158; J158; J159; J157; J168; J180; J189; J690; J698; J9589
Infections (included pneumonia, listed above)	998.51; 998.59; 038.0; 038.10; 038.11; 038.12; 038.19; 038.2; 038.40; 038.42; 038.43; 038.44; 038.49; 038.8; 038.9; 495.7; 785.52; 790.7; 995.91; 995.92; 997.31; A403; A409; A4101; A4102; A411; A412; A4150; A4151; A4152; A4153; A4159; A4189; A419; J677; J95851; K68.11; R6520; R6521; R7881; T81.4XXA

Supplemental Table 2. Unadjusted Outcomes, Primary Analyses

	Powered Staplers n=659	Manual Staplers n=3100
Hospital LOS, mean (SD)	4.5 (3.6)	5.9 (4.8)
Median	4	5
Total Hospital Costs, mean (SD)	\$23,675 (\$12,400)	\$25,573 (\$23,541)
Median	\$20,768	\$21,543
Supply Cost, mean (SD)	\$6184 (\$3960)	\$5788 (\$4621)
Median	\$5625	\$4599
Room and Board Cost, mean (SD)	\$5785 (\$5569)	\$8075 (\$10059)
Median	\$4467	\$5919
Operating Room Cost, mean (SD)	\$7743 (\$3700)	\$6851 (\$4271)
Median	\$7148	\$5953
Discharge to Non-home ^a	31 (4.7%)	269 (8.7%)
Operating Room Time ^b , mean (SD)	244 (60.7)	227 (66.0)
Median	240	225
In-hospital Complications		
Bleeding/Transfusion	50 (7.6%)	517 (16.7%)
Transfusion	33 (5.0%)	354 (11.4%)
APHA	22 (3.3%)	230 (7.4%)
Air Leak Complications ^c	169 (25.6%)	770 (24.8%)
Pneumonia	16 (2.4%)	117 (3.8%)
Infection	17 (2.6%)	131 (4.2%)
All-cause Readmission ^d		
≤30 days	19 (3.0%)	133 (4.4%)
≤60 days	33 (5.7%)	213 (7.2%)
≤90 days	42 (7.7%)	279 (9.7%)

APHA acute post-hemorrhagic anemia, LOS length of stay

^a Discharge to a non-home setting (e.g. skilled nursing facility, intermediate care facility) vs. discharge to home with or without home health care

^b In minutes; n with operating room time data = 542 Powered; 2711 Manual; operating room time values trimmed to fall between 30 minutes and 24 hours

^c Composite of air leak and/or pneumothorax

^d 30, 60, and 90-day all-cause readmissions to the hospital in which the VATS lobectomy procedure was performed; N with hospital-level follow-up data for at least 30 days = 624 Powered; 3018 Manual; for at least 60 days = 581 Powered; 2942 Manual; for at least 90 days = 545 Powered; 2866 Manual

Supplemental Table 3. Propensity Score Match Sensitivity Analysis, Primary Analyses

Outcome	Adjusted Outcomes ^a		P	% Difference (Powered – Manual)
	Powered Staplers n=319	Manual Staplers n=587		
Hospital LOS	4.62	5.86	<0.001	-21.2%
Total Hospital Costs	\$23,104	\$26,063	0.006	-11.4%
Supply Cost	\$5319	\$6123	0.121	-13.1%
Room and Board Cost	\$6283	\$7610	0.010	-17.4%
Operating Room Cost	\$7292	\$7650	0.304	-4.7%
Discharge to Non-home ^b	5.5%	5.5%	0.979	0.0%
Operating Room Time ^c	275	308	0.004	-10.7%
In-hospital Complications				
Bleeding/Transfusion	13.3%	20.7%	0.002	-35.7%
Transfusion	8.9%	16.1%	0.002	-44.7%
APHA	6.0%	6.0%	0.979	0.0%
Air Leak Complications ^d	24.7%	28.1%	0.312	-12.1%
Pneumonia	3.0%	2.8%	0.824	7.1%
Infection	4.5%	3.9%	0.711	15.4%
All-cause Readmission ^e				
≤30 days	3.1%	4.1%	0.539	-24.4%
≤60 days	5.2%	7.0%	0.375	-25.7%
≤90 days	6.9%	8.5%	0.543	-18.8%

APHA acute post-hemorrhagic anemia, LOS length of stay

^a Recycled prediction method;

^b Discharge to a non-home setting (e.g. skilled nursing facility, intermediate care facility) vs. discharge to home with or without home health care

^c In minutes; n with operating room time data = 253 Powered; 516 Manual; operating room time values trimmed to fall between 30 minutes and 24 hours

^d Composite of air leak and/or pneumothorax

^e 30, 60, and 90-day all-cause readmissions to the hospital in which the VATS lobectomy procedure was performed; N with hospital-level follow-up data for at least 30 days = 303 Powered; 565 Manual; for at least 60 days = 283 Powered; 543 Manual; for at least 90 days = 264 Powered; 524 Manual

Supplemental Table 4. Propensity Score Match Sensitivity Analysis: Patient Demographics

	Powered Staplers n=319	Manual Staplers n=587; n=319 weighted ^a	Std. Diff. ^a
Age Group, n (%)			
18-44	11 (3.5)	11 (3.3)	0.01
45-54	30 (9.4)	26 (8.2)	0.04
55-64	87 (27.3)	86 (27.0)	0.01
≥65	191 (59.9)	196 (61.6)	-0.03
Sex, n (%)			
Female	183 (57.4)	177 (55.6)	0.04
Male	136 (42.6)	142 (44.4)	-0.02
Marital Status, n (%)			
Married	188 (58.9)	194 (60.8)	-0.04
Single	122 (38.2)	117 (36.7)	0.03
Other	9 (2.8)	8 (2.5)	0.02
Race, n (%)			
White	264 (82.8)	259 (81.1)	0.04
Black	28 (8.8)	30 (9.4)	-0.02
Other	27 (8.5)	30 (9.4)	-0.04
Hispanic, n (%)	32 (10.0)	33 (10.2)	-0.01
Payer Type, n (%)			
Medicare	187 (58.6)	186 (58.4)	0.01
Commercial	103 (32.3)	105 (32.9)	-0.01
Medicaid	14 (4.4)	15 (4.6)	-0.01
Other	15 (4.7)	13 (4.1)	0.03
Index Hospitalization Year, n (%)			
2012	13 (4.1)	65 (20.4)	-0.51
2013	70 (21.9)	28 (8.7)	0.37
2014	67 (21.0)	69 (21.6)	-0.01
2015	105 (32.9)	95 (29.8)	0.07
2016	64 (20.1)	62 (19.4)	0.03

SD standard deviation, Std. Diff. standardized difference

^a Proportions weighted to account for variable-ratio matching and subject to rounding error and weighting; standardized difference applied to weighted proportions, >0.10 indicates imbalance across the cohorts

Supplemental Table 5. Propensity Score Match Sensitivity Analysis: Patient Clinical

Characteristics

	Powered Staplers n=319	Manual Staplers n=587; n=319 weighted^a	Std. Diff.^a
Primary Diagnosis of Cancer, n (%)	293 (91.9)	291 (91.3)	0.02
Comorbidities, n (%)			
Cancer [metastatic]	54 (16.9)	48.8 (15.3)	0.04
Cerebrovascular disease	7 (2.2)	6 (1.9)	0.02
COPD ^b	135 (42.3)	141 (44.3)	-0.04
Coagulopathy	8 (2.5)	7 (2.2)	0.02
Congestive heart failure	20 (6.3)	17 (5.4)	0.04
Connective tissue/rheumatic disease	13 (4.1)	13 (4.1)	0
Depression	35 (11.0)	35 (11.0)	0
Diabetes [w/complications]	3 (0.9)	2 (0.7)	0.02
Diabetes [w/o complications]	48 (15.1)	53 (16.5)	-0.04
Hypertension [complicated]	18 (5.6)	18 (5.6)	0
Hypertension [uncomplicated]	177 (55.5)	183 (57.4)	-0.04
Hypothyroidism	37 (11.6)	35 (11.1)	0.02
Liver disease [mild]	7 (2.2)	5 (1.6)	0.05
Myocardial infarction	16 (5.0)	18 (5.6)	-0.02
Neurological disorders	6 (1.9)	4 (1.4)	0.04
Obesity ^c	39 (12.2)	46 (14.4)	-0.06
Peripheral vascular disease	16 (5.0)	20 (6.3)	-0.05
Renal disease	19 (6.0)	20 (6.3)	-0.02
Valvular disease	12 (3.8)	13 (4.2)	-0.02
Weight loss	9 (2.8)	7 (2.1)	0.05
CCI, n (%)			
0-1	37 (11.6)	32 (10.0)	0.05
2	84 (26.3)	91 (28.6)	-0.05
3	92 (28.8)	89 (27.9)	0.02
4	30 (9.4)	32 (10.1)	-0.02
5+	76 (23.8)	75 (23.5)	0.01
Day of Procedure ^d , mean (SD)	1.04 (0.3)	1.03 (0.2)	0.05
Concomitant Wedge Resection, n (%)	22 (6.9)	20 (6.2)	0.03
Concomitant Segmentectomy, n (%)	2 (0.6)	1 (0.3)	0.03
Robotic-assisted Procedure, n (%)	61 (21.6)	82 (25.7)	-0.09

CCI Charlson Comorbidity Index, COPD chronic obstructive pulmonary disease, SD standard deviation, Std. Diff. standardized difference

^a Proportions weighted to account for variable-ratio matching and subject to rounding error and weighting; standardized difference applied to weighted proportions, >0.10 indicates imbalance across the cohorts

^b Comprising chronic obstructive pulmonary disease and allied disorders, according to the ICD-9-CM/ICD-10-CM taxonomies

^c Based on ICD-9-CM/ICD-10-CM coding generally corresponding to body mass index ≥ 30 kg/m²

^d Day on which VATS lobectomy procedure was performed; value of 1 indicates day of admission

Supplemental Table 6. Propensity Score Match Sensitivity Analysis: Hospital and Provider

Characteristics

	Powered Staplers n=319	Manual Staplers n=587; n=319 weighted^a	Std. Diff.^a
US Geographic Region, n (%)			
South	238 (74.6)	232 (72.8)	0.04
Midwest	4 (1.3)	5 (1.7)	-0.03
Northeast	16 (5.0)	17 (5.4)	-0.02
West	61 (19.1)	64 (20.1)	-0.02
Rural, n (%)	32 (10.0)	38 (11.8)	-0.06
Non-teaching, n (%)	171 (53.6)	160 (50.0)	0.07
Cost Type: Cost-to-Charge Ratio ^b , n (%)	37 (11.6)	45 (14.2)	-0.08
Bed Size, n (%)			
0-299	49 (15.4)	59 (18.5)	-0.08
300-399	60 (18.8)	54 (16.8)	0.05
400-499	80 (25.1)	81 (25.4)	-0.01
≥500	130 (40.8)	125 (39.3)	0.03
Surgical Specialty, n (%)			
Thoracic	258 (80.9)	266 (83.3)	-0.06
Cardiovascular	43 (13.5)	38 (12.0)	0.04
General	6 (1.9)	7 (2.1)	-0.01
Other	12 (3.8)	8 (2.6)	0.07
Monthly Surgical Volume Ratio ^c , n (%)			
≤ 0.75	70 (21.9)	82 (25.7)	-0.09
≥ 0.75 < 2	82 (25.7)	85 (26.7)	-0.02
≥ 2 <4	82 (25.7)	75 (23.6)	0.05
≥ 4	85 (26.7)	77 (24.0)	0.06

SD standard deviation, *Std. Diff.* standardized difference

^a Proportions weighted to account for variable-ratio matching and subject to rounding error and weighting; standardized difference applied to weighted proportions, >0.10 indicates imbalance across the cohorts

^b Procedural costing is reference

^c Ratio of the number of VATS lobectomy procedures to the number of months the patient's hospital was present in database during the study period.