

## Supplementary Online Content

Epstein AJ, Groeneveld PW, Harhay MO, Yang F, Polsky D. Impact of minimally invasive surgery on medical spending and employee absenteeism. *JAMA Surg*. Published online March 20, 2013. doi:10.1001/jamasurg.2013.131.

**eAppendix.** Methods

**eReference**

**eTable 1.** Cohort Coding Definitions

**eTable 2.** Cohort Exclusions by Indication

**eTable 3.** Patient Characteristics (Full Sample)

**eTable 4.** Patient Characteristics (Absent Days Sample)

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

## eAppendix: Methods

We used the method of multiple imputation to account for missing data on workplace absence.<sup>1</sup> We limited the absent-days subsample to those individuals with non-missing data on at least one of paid time off absence (i.e., vacation and sick leave) and short-term disability absence. The time around the index surgery date was divided into three periods: baseline (–380 days to –15 days), perioperative (–14 days to +28 days) and post-operative (+29 days to +352 days). For each individual in each time period for each type of absence data, we calculated the minimum and maximum number of possible days absent for that type of absence data.

For individuals with non-missing absence data, the minimum and maximum for the interval-dependent variable were both set to the number of observed missing days. For individuals with missing absence data, the minimum was set to 0 and the maximum was set to the number of eligible days for that time period. The number of eligible days for a given time period was defined as the maximum possible for that time period (130 for baseline [the maximum number of total absent days observed in the data for any indication], 30 for perioperative, and 230 for post-operative [the maximum number of absent days possible assuming five workdays per week]) minus the number of days absent observed in the other type of absence data for the same time period. For example, suppose a patient was missing data on paid-time-off absences and missed 20 days of work during the baseline period based on the short-term disability data. That patient would have to have missed between 0 and 110 (= 130–20) days of paid time off during the baseline period.

For each of the six surgical procedures separately, we executed the following algorithm 1,000 times:

- 1) For each of the three time periods and two absence data types, we estimated an interval regression model at the individual patient level predicting the number of days absent during that period as a function of the number of inpatient hospital days and number of days with an outpatient visit experienced by the individual during that time period. From the fitted regression results, we calculated for each individual the predicted number of days absent given their inpatient and outpatient days, where the predicted value was forced to be in the interval between the individual-specific minimum and maximum number of absent days inclusive (as described above). For individuals with non-missing absence data, we calculated the standard deviation of the residuals (the difference between the actual and predicted number of days absent). For individuals with missing absence data, we imputed their number of missing days as the sum of the predicted value from the interval regression and a random draw from a normal distribution with mean 0 and variance equal to the calculated standard deviation of the residuals.
- 2) We summed the number of days absent across data types (and across the peri- and postoperative time periods) before estimating the selected ANOVA or regression model.

We combined the results of the 1,000 iterations of the multiple imputation process by taking the means of the estimated model coefficients and calculating their standard errors using the general formula.<sup>1</sup>

## eReference

1. Allison PD. *Missing Data*. Sage: Thousand Oaks, CA; 2002

**eTable 1. Cohort Coding Definitions**

Category	ICD-9 Dx	Procedure	Approach	ICD-9 Proc	CPT
Coronary revascularization	410.xx– 414.xx	CABG	Open	36.1x	33510–33519, 33521–33523, 33530–33536
		PCI	MI	36.01–36.07	92980–92982, 92984, G0290, G0291
Uterine fibroid resection	218.x or 654.1x	Non-laparoscopic abdominal hysterectomy	Open	68.39, 68.49, 68.69	58150, 58152, 58200
		Other hysterectomy	MI	68.31, 68.41, 68.51, 68.59, 68.61, 68.71, 68.79, 68.9	58260, 58262, 58263, 58267, 58270, 58275, 58280, 58285, 58290–58294, 58550, 58552– 58554, 56308, 58180, 58210
		Abdominal myomectomy	Open	68.29	58140, 58146
		Other myomectomy	MI	n/a	58145, 58545, 58546
		Endometrial ablation	MI	68.23	56356, 58353, 58561, 58563
		Uterine artery embolization	MI	n/a	36247, 37204, S2250, 37210
Prostatectomy	185, 198.82, 233.4	Radical prostatectomy	Open	60.5	55840, 55842, 55845
		Laparoscopic prostatectomy	MI	n/a	55866, 55899
		Robotic lap prostatectomy	MI	17.42	S2900
Peripheral revascularization	443.9, 440.2x	PVD surgery	Open	39.25, 39.29	35531–35571, 35631–35666
		PVD stent	MI	00.45–00.48, 00.55	34570–35476, 37205–37208
Carotid revascularization	433.10, 433.11, 433.30, 433.31	Carotid endarterectomy	Open	38.12	35301
		Carotid stent	MI	00.61, 00.63	37215, 37216
Aortic aneurysm repair	441.02, 441.1–441.9	Aortic aneurysm repair	Open	38.34, 38.44, 38.64	34830–34832, 35001–35162
		Catheter-based treatment	MI	39.71, 39.73	34800, 34802, 34804

Note: MI indicates minimally invasive

**eTable 2. Cohort Exclusions by Indication**

	<b>Coronary revasc</b>	<b>Uterine fibroid resection</b>	<b>Prostatectomy</b>	<b>Peripheral revasc</b>	<b>Carotid revasc</b>	<b>Aortic aneurysm repair</b>	<b>Total</b>
N initial	324,882	241,116	45,012	35,385	21,815	5,627	673,837
Exclusion for incomplete insurance coverage	-167,706	-128,126	-21,062	-18,955	-11,325	-3,028	-350,202
Exclusion for total spending < \$1	-929	-395	-90	-163	-79	-23	-1,679
N cost analysis	156,247	112,595	23,860	16,267	10,411	2,576	321,956
Exclusion for missing absenteeism data	-144,018	-105,193	-21,505	-15,167	-9,846	-2,413	-298,142
N days absent analysis	12,229	7,402	2,355	1,100	565	163	23,814

**eTable 3. Patient Characteristics (Full Sample)**

	Coronary revascularization			Uterine fibroid resection			Prostatectomy		
	Traditional	MI	P	Traditional	MI	P	Traditional	MI	P
N	37,677	118,570	--	58,803	53,287	--	13,735	10,125	--
Age (mean, SD)	55.8 (5.6)	54.7 (6.2)	<0.001	43.9 (6.8)	44.3 (6.7)	<0.001	56.7 (4.7)	56.5 (4.7)	<0.001
Age group (%)									
18-35	0.2	0.5	<0.001	9.0	7.3	<0.001	0.0	0.0	0.01
36-45	4.3	6.8		42.8	42.8		1.6	1.9	
46-55	29.3	34.3		42.8	43.7		27.0	28.5	
56-64	66.2	58.4		5.5	6.2		71.4	69.6	
Sex (%)									
M	79.3	75.7	<0.001	0.0	0.0	--	100.0	100.0	--
F	20.7	24.3		100.0	100.0		0.0	0.0	
# Comorbidities (%)									
0	0	0.1	<0.001	62.1	66.0	0.46	39.1	37.9	0.06
1	42.3	49.7		26.1	23.6		36.5	36.9	
2	31.6	31.7		8.3	7.3		17.3	17.4	
≥3	26.1	18.6		3.5	3.1		7.1	7.8	
Census region (%)									
North East	7.9	8.8	<0.001	7.1	8.8	<0.001	10.6	10.3	<0.001
North Central	29.3	31.4		20.9	20.9		28.9	30.8	
South	53.3	49.8		61.0	56.2		44.9	46.4	
West	9.1	9.6		10.6	13.8		15.3	12.1	
Unknown	0.4	0.4		0.5	0.3		0.3	0.3	
Residence (%)									
Rural	25.6	23.7	<0.001	20.2	17.4	<0.001	20.9	14.8	<0.001
Urban	74.4	76.3		79.8	82.6		79.1	85.2	
Health plan type (%)									
Less restrictive	71.8	72.2	0.14	63.7	65.6	<0.001	70.5	71.8	0.03
More restrictive	28.2	27.8		36.3	34.4		29.5	28.2	

Note: MI indicates minimally invasive

**eTable 3. Patient Characteristics (Full Sample) (cont)**

	Peripheral revascularization			Carotid revascularization			Aortic Aneurysm Repair		
	Traditional	MI	P	Traditional	MI	P	Traditional	MI	P
N	3,501	12,766	--	9,710	701	--	1,495	1,081	--
Age (mean, SD)	56.0 (5.4)	55.9 (5.6)	0.34	57.7 (4.4)	57.6 (4.8)	0.52	58.2 (4.4)	58.7 (4.2)	<0.001
Age group (%)									
18-35	0.2	0.3	0.71	0.1	0.3	0.07	0.2	0.3	0.07
36-45	3.6	3.9		1.1	1.6		0.9	0.7	
46-55	29.1	29.4		19.5	19.7		15.5	11.9	
56-64	67.1	66.4		79.4	78.5		83.3	87.0	
Sex (%)									
M	65.7	64.9	0.38	60.3	62.5	0.25	87.6	90.0	0.06
F	34.3	35.1		39.7	37.5		12.4	10.0	
# Comorbidities (%)									
0	12.1	13.3	<0.001	17.5	12.4	<0.001	16.3	12.7	0.04
1	26.9	29.3		35.2	35.1		29.4	28.1	
2	26.2	25.4		25.6	25.0		26.0	27.7	
≥3	34.8	32		21.7	27.5		28.4	31.5	
Census region (%)									
North East	9	7.2	<0.001	9.2	6.4	0.03	10.4	7.5	0.01
North Central	29.4	32.1		31.6	33.2		34.0	30.7	
South	52.8	52.5		50.2	52.8		45.2	51.5	
West	8.3	7.9		8.6	7.0		10.0	9.6	
Unknown	0.4	0.3		0.3	0.6		0.4	0.6	
Residence (%)									
Rural	24.6	23.8	0.30	26.1	20.0	<0.001	25.4	23.5	0.26
Urban	75.4	76.2		73.9	80.0		74.6	76.5	
Health plan type (%)									
Less restrictive	71.9	73.7	0.03	74.1	75.2	0.54	73.2	72.4	0.65
More restrictive	28.1	26.3		25.9	24.8		26.8	27.6	

Note: MI indicates minimally invasive

**eTable 4. Patient Characteristics (Absent Days Sample)**

	Coronary Revascularization			Uterine Fibroids			Prostatectomy		
	Traditional	MI	P	Traditional	MI	P	Traditional	MI	P
N	2,668	9,561		4,137	3,259		1,291	1,064	
Age (mean, SD)	53.8 (5.7)	52.6 (6.1)	<0.001	42.6 (6.3)	43.4 (6.1)	<0.001	54.6 (4.8)	54.6 (4.8)	0.91
Age group (%)									
18-35	0.3	0.8	<0.001	10.9	8.0	<0.001	0.0	0.0	0.71
36-45	6.6	9.6		48.9	47.8		2.6	3.0	
46-55	42.9	47.8		37.7	41.3		42.6	43.7	
56-64	50.3	41.8		2.5	2.9		54.8	53.3	
Sex (%)									
M	90.1	88.4	0.02	0.0	0.0	--	100.0	100.0	--
F	9.9	11.6		100.0	100.0		0.0	0.0	
# Comorbidities (%)									
0	0.0	0.0	<0.001	76.4	81.3	<0.001	52.7	52.0	0.29
1	60.4	66.2		18.7	15.6		34.5	32.7	
2	27.7	26.7		3.8	2.3		10.2	12.7	
≥3	11.9	7.1		1.1	0.8		2.6	2.6	
Census region (%)									
North East	11.7	12.9	<0.001	15.9	19.6	<0.001	16.7	15.4	0.01
North Central	38.1	41.5		20.2	22.9		30.8	37.3	
South	39.8	35.7		52.1	43.3		37.2	32.0	
West	10	9.8		10.7	14.1		15.1	15.2	
Unknown	0.4	0.1		1.2	0.2		0.2	0.0	
Residence (%)									
Rural	14.8	14.7	0.95	6.9	6.8	0.89	9.9	8.7	0.33
Urban	85.2	85.3		93.1	93.2		90.1	91.3	
Health plan type (%)									
Less restrictive	67.6	69.7	0.04	42.3	44.9	0.03	65.2	72.2	<0.001
More restrictive	32.4	30.3		57.7	55.1		34.8	27.8	

Note: MI indicates minimally invasive

**eTable 4. Patient Characteristics (Absent Days Sample) (cont)**

	Peripheral revascularization			Carotid revascularization			Aortic aneurysm repair		
	Traditional	MI	P	Traditional	MI	P	Traditional	MI	P
N	234	866		525.00	40		92	71	
Age (mean, SD)	54.2 (5.3)	54.5 (5.3)	0.58	56.3 (4.9)	55.7 (3.9)	0.49	56.1 (6.0)	57.2 (3.9)	0.19
Age group (%)									
18-35	0.4	0.2	0.54	0.2	0.0	0.69	1.1	0.0	0.67
36-45	4.3	4.6		1.3	0.0		2.2	1.4	
46-55	45.3	40.4		30.1	37.5		26.1	21.1	
56-64	50.0	54.7		68.4	62.5		70.7	77.5	
Sex (%)									
M	73.5	80.0	0.03	70.7	85.0	0.05	91.3	97.2	0.12
F	26.5	20.0		29.3	15.0		8.7	2.8	
# Comorbidities (%)									
0	22.2	18.8	0.48	24.2	27.5	0.79	19.6	16.9	0.66
1	34.6	39.1		40.4	45.0		28.3	36.6	
2	26.1	26.7		24.8	20.0		28.3	28.2	
≥3	17.1	15.4		10.7	7.5		23.9	18.3	
Census region (%)									
North East	9.8	10.7	0.08	16.0	10.0	0.33	17.4	15.5	0.69
North Central	32.9	41.9		39.6	52.5		40.2	33.8	
South	46.2	37.8		34.3	35.0		34.8	40.8	
West	11.1	9.4		9.9	2.5		6.5	9.9	
Unknown	0.0	0.2		0.2	0.0		1.1	0.0	
Residence (%)									
Rural	16.7	16.5	0.96	15.8	12.5	0.58	12.0	11.3	0.89
Urban	83.3	83.5		84.2	87.5		88.0	88.7	
Health plan type (%)									
Less restrictive	67.5	74.7	0.03	71.4	75.0	0.63	65.2	66.2	0.90
More restrictive	32.5	25.3		28.6	25.0		34.8	33.8	

Note: MI indicates minimally invasive