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Examining Variation in Medicare Payments and Drivers of Cost for Carotid Endarterectomy

Danielle C. Sutzko, MD, MS^{*1}, Elizabeth A. Andraska, MD, MS^{*2}, Andrew A. Gonzalez, MD, MS, JD¹, Apurba K. Chakrabarti, MD¹, and Nicholas H. Osborne, MD, MS¹

¹Section of Vascular Surgery, Michigan Medicine, University of Pittsburgh Medical Center

²Section of Vascular Surgery, University of Pittsburgh Medical Center

Abstract

Background—There is growing interest in providing high quality and low-cost care to Americans. A pursuit exists to measure not only how well hospitals are performing, but also at what cost. We examined the variation in costs associated with carotid endarterectomy (CEA), to determine which components contribute to the variation and what drives increased payments.

Materials and Methods—Patients undergoing CEA between 2009 and 2012 were identified in the Medicare Provider and Analysis Review database. Hospital quintiles of cost were generated and variation examined. Multivariable logistic regression was performed to identify independent predictors of high payment hospitals for both asymptomatic and symptomatic patients undergoing CEA.

Results—A total of 264,018 CEAs were performed between 2009 and 2012; 250,317 were performed in asymptomatic patients at 2,302 hospitals and 13,701 in symptomatic patients in 1,851 hospitals. Higher payment hospitals had a higher percentage of non-white patients and comorbidity burden. The largest contributors to variation in overall payments were diagnosis related groups (DRGs), post-discharge, and readmission payments. After accounting for clustering at the hospital level, independent predictors of high payment hospitals for all patients were post-operative stroke, length of stay (LOS) and readmission whereas in the symptomatic group additional drivers included yearly volume and serious complications.

Conclusion—CEA Medicare payments vary nationwide with DRG, readmission and post-discharge payments being the largest contributors to overall payment variation. In addition, stroke, LOS and readmission were the only independent predictors of high payment for all patients undergoing CEA.

Corresponding author: Danielle C. Sutzko, MD, MS, University of Michigan Health System, 1500 E. Medical Center Drive, Cardiovascular Center – 5463, Ann Arbor, MI 48109-5867, horned@med.umich.edu, Phone: 734-936-5820; FAX: 734-936-5847.

^{*}Co-first authors

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Keywords

Carotid endarterectomy; Medicare payment; Episode bundled payment; Healthcare reform; Variation

BACKGROUND

Recently, there has been growing interest in providing high hospital quality care at lower cost to Americans.¹ It has been estimated that with the Affordable Care Act (ACA), signed in March 2010, the impact of healthcare reform would save nearly six hundred billion dollars in health care spending.² In fact, more recent estimates suggest even more savings than initially expected given the slowing of new drug development and imaging technology.³ Ultimately, achieving the goal of the “triple aim”, proposed by Berwick et al, to ensure improvement of patient experience, the overall health of populations and reducing the price per capita remains a challenge.⁴ Nonetheless, policymakers, payers and healthcare leaders are charged with optimizing the delivery of healthcare, as the United States spends more than any other country despite the most recent World Health Organization ranking of 31st for life expectancy.⁵ One strategy is to eliminate wasteful spending by incorporating widespread best practices, minimizing overtreatment and fixing pricing failures.⁶ An alternative strategy is to implement payment reform. Among the multiple payment reforms that have been considered, bundled episode-based payment models may represent a more optimal solution and have already been rolled out in cardiac and orthopedic surgery.⁷

Within the bundled episode-payment model, variation in Medicare payments has yet to be examined for carotid endarterectomy.^{8–10} Previous studies have found wide variation in Medicare payments suggesting that there are areas for improvement and cost savings for payers.^{9,11,12} However, undue burden may be placed on hospitals that treat more complex patients if bundled payments are put into place.¹³ After reviewing some initial examples of bundled payments, Shih et al found that savings were modest at best. For example, bundled payments for percutaneous coronary interventional procedures saved approximately \$71 after accounting for post-discharge care.¹⁴

Similar to previously studied cardiac procedures; carotid endarterectomy (CEA) is a straightforward, common operation with the majority of patients being discharged home on post-operative day 1. Given the frequency of CEA performed by vascular surgeons, we sought to (1) investigate variation in Medicare payments associated with carotid endarterectomy, particularly focusing on the different components of total payments: including diagnosis related group (DRG), outlier, readmission, physician and post-discharge payments and (2) examine the relationship of patient, operative and post-operative factors with Medicare payments. Ultimately, we aimed to determine which component is the main contributor to the variation seen after carotid endarterectomy and to identify drivers of increased payments.

MATERIALS AND METHODS

Study design

We performed a retrospective cohort study using the Medicare Provider Analysis and Review (MedPar) database. We identified all patients undergoing carotid endarterectomies from 2009 to 2012 using International classification of diseases 9 (ICD-9) codes. Carotid procedures performed with other concurrent major surgeries (e.g. coronary artery bypass) and all carotid stenting procedures were excluded from the analysis. Given the vast differences between patient populations, patients were separated by symptomatic status for analysis. Symptomatic status was determined by ICD-9 codes (Figure 1).

Next, we examined hospital payment data across the United States for all included cases. Using a similar algorithm to account for regional cost variation previously described, we completed our price standardization for all hospitals^{9,15,16}. To accomplish this, patient records are linked to Centers for Medicare and Medicaid Services (CMS) files containing claims for services related to an index procedure. Payments were then measured for all services from the date of admission for the index procedure to 30 days following discharge from the hospital. Since Medicare payments vary depending on region the procedure was performed, teaching status of the hospital and disproportionate share, payments were adjusted for these known factors as previously described by Gottlieb et al and Birkmeyer et al.^{15,16} This method is similar to the algorithms used by CMS. Since CMS adjusts DRG payments based upon regional differences in the cost of care, a method must be used to adjust for this purposeful variation. Using methods commonly used in the Dartmouth Atlas, the DRG payments across region are compared and an adjuster is used to account for this variation. This method essentially accounts for the geographic variation in reimbursement by normalizing payments across regions for specific DRGs. After payment standardization, we calculated a composite total payment for each hospital. Hospitals were then grouped into five separate payment quintiles, but for simplicity will report the differences between the lowest and highest hospital payment quintile. The study was deemed exempt from IRB approval as all data was de-identified and consent was not required.

Outcomes

The primary goal of this analysis was to describe the variation between the payment components (DRG, outlier, readmission, physician and post-discharge payments) for each hospital quintile. The secondary outcome was to examine the association between patient, operative and post-operative with high payment hospitals.

Statistical analysis

For the descriptive analysis of the variation between payment components for each hospital quintile we generated a frequency table and calculated the percent of total change, and the ratio increase between the lowest and highest quintile. Next, we described and compared patient demographics, baseline comorbidities, operative volume and post-operative characteristics for the low and high payment quintiles. The two groups were compared using bivariate statistics. Student t-test was used for continuous variables and Chi squared test was used for categorical variables.

To evaluate the association of patient, operative and post-operative characteristics with high payment hospitals, we performed a multivariable logistic regression model accounting for clustering at the hospital level, including all hospitals performing CEA. Two independent regression models were performed, one for asymptomatic patients and one for symptomatic patients. To minimize covariance, Elixhauser scores were included as a surrogate for all patient comorbidities. Elixhauser has been established as an accurate method of capturing overall patient comorbidity burden.¹⁷ Similarly, a variable for serious complications was included in the model, as a measurement of post-operative complications that allowed minimal covariance. The variable for serious complications was defined as any complication (pneumonia, DVT/PE, acute renal failure, hemodialysis, GI bleed, shock and sepsis) that was associated with a hospital stay greater than the 75th percentile.

Alpha was set at 0.05 for statistical significance. All statistical analyses were performed in STATA 14.0 software (StataCorp LP, College Station, TX).

RESULTS

Total and Component Payments

A total of 264,018 CEAs were included in the study cohort; 250,317 asymptomatic CEAs performed at 2,302 hospitals and 13,701 symptomatic CEAs performed at 1,851 hospitals. When examining the five quintiles of payments for both asymptomatic and symptomatic patients, there was significant variation in both total payments and the proportion of payments attributable to DRG, outlier, readmission, physician and post-discharge payments (Figure 2). In asymptomatic patients, total payments increased nearly 2-fold between lowest and highest payment quintiles. In the symptomatic group, total payments increased almost 4-fold between lowest and highest payment quintiles. Table I demonstrates the proportion of payments attributable to DRG, outlier, readmission, physician and post-discharge payments. In both asymptomatic and symptomatic groups, DRG and post-discharge payments contributed most to the variation in the overall magnitude of payments. For asymptomatic patients, readmission payments were the third highest contributor to the variation whereas for symptomatic patients, physician and readmission payments were nearly tied for the third largest contributor. However, outlier payments varied the most overall, with a 45-fold increase in the asymptomatic group and a 130-fold increase in the symptomatic group, comparing quintile 1 to quintile 5.

Patient Characteristics and Procedural Volume

Table II summarizes patient demographics, baseline comorbidities, and operative volume for low and high payment quintile hospitals in asymptomatic and symptomatic groups. Age did not vary significantly from a clinical perspective (74.51–75.69 years). The highest payment hospitals had a lower proportion of men in the asymptomatic group (55.70% vs. 57.97%, $p < .001$). In both asymptomatic and symptomatic groups, high payment hospitals had a higher percentage of non-white patients (10.73 vs. 5.80, $p < .001$; 14.60 vs. 11.15, $p = .004$), comorbidity burden including CHF, uncomplicated DM, COPD and renal failure, reflected in a higher overall Elixhauser comorbidity scores (2.46 ± 1.46 vs. 2.12 ± 1.33 , $p < .001$; 2.67 ± 1.53 vs. 2.26 ± 1.32 , $p < .001$). The higher payment hospitals had a lower yearly volume in

the asymptomatic group but a higher yearly volume in the symptomatic group (41.11 ± 33.13 vs. 55.03 ± 42.85 , $p < .001$; 2.77 ± 2.22 vs. 197 ± 1.59 , $p < .001$).

Post-operative Characteristics

Table III describes the post-operative characteristics including post-operative complications, mortality, length of stay (LOS) and 30-day readmission for lowest and highest payment hospitals according to symptomatic status. Overall post-operative complications were low following both symptomatic and asymptomatic CEA. However, between lowest and highest payment quintile hospitals, all post-operative complications increased significantly for both the symptomatic and asymptomatic groups. Symptomatic patients saw higher rates of complications than asymptomatic patients, and higher post-operative mortality. However, while statistically significant, the post-operative mortality rate did not vary significantly from a clinical perspective between payment quintiles for asymptomatic and symptomatic patients ($0.78\% \pm .11$ vs. $0.76\% \pm .07$, $p < .001$; $2.49\% \pm .04$ vs. $2.48\% \pm .02$, $p < .001$). Stroke was significantly higher in the high payment hospitals and higher rates of stroke were seen in patients with symptomatic carotid artery stenosis ($1.20 \pm .16$ vs. $5.17 \pm .27$, $p < .001$, $0.50 \pm .73$ vs. 1.46 ± 2.11 , $p < .001$). LOS did vary significantly between quintiles in symptomatic and asymptomatic groups, and was much longer in the symptomatic group (9.07 ± 8.78 vs. 4.31 ± 3.63 , $p < .001$; 3.16 ± 3.88 vs. 1.75 ± 1.98 , $p < .001$). 30-day readmissions were also higher in the highest payment quintile for both asymptomatic and symptomatic CEAs (11.37% vs. 6.02% , $p < .001$; 26.08% vs. 4.14% , $p < .001$).

Independent Predictors of Total Payment

To evaluate the independent association of patient, operative and post-operative characteristics with total payments, we performed a multivariable logistic regression model accounting for clustering at the hospital level with the likelihood to receive care in highest payment hospital quintile as our outcome variable. The multivariable analysis is described for asymptomatic CEAs in Table IV and symptomatic CEAs in Table V.

In the asymptomatic group, age was not associated with high payment hospitals (OR 1.00, 95% CI [0.99 – 1.00], $p = .145$) but white race and Elixhauser scores were associated with highest payment hospitals (OR 0.67, 95% CI [0.55 – 0.82], $p < .001$; OR 1.11 95% CI [1.07 – 1.15], $p < .001$). Yearly volume was not associated with payments in asymptomatic patients (OR 0.99, 95% CI [0.98 – 1.00], $p = .05$) and serious complications were associated with lower payment hospitals (OR 0.83, 95% CI [0.70 – 0.99], $p = .035$). LOS and readmission were both independently associated with high payment status (OR 1.23, 95% CI [1.19 – 1.27], $p < .001$; OR 1.53, 95% CI [1.42 – 1.64], $p < .001$). Finally, stroke had the largest independent predictors of high payment hospitals with an odds ratio of 1.34 e^{39} (95% CI [4.79 e^{27} – 3.76 e^{50}], $p < .001$)

Conversely, in the symptomatic group, patient characteristics including age, race and Elixhauser score were not independently associated with high payment hospitals (OR 1.01, 95% CI [1.00 – 1.02], $p = .162$; OR 0.95, 95% CI [0.70 – 1.29], $p = .726$; OR 1.04 95% CI [0.97 – 1.11], $p = .320$). Variables including yearly volume (OR 1.28, 95% CI [1.09 – 1.50], $p = .003$), stroke (OR 3,375, 95% CI [25.82 - 441,094.20], $p < .001$), serious complications

(OR 2.00, 95% CI [1.47 – 2.7], $p < .001$), LOS (OR 1.23, 95% CI [1.18 – 1.27], $p < .001$) and readmission (OR 5.94, 95% CI [4.34 – 8.13], $p < .001$) were all independently associated with high payment hospitals in the symptomatic group. Again, with stroke being the largest independent predictor of high payment hospitals in symptomatic patients.

DISCUSSION

In this retrospective review of the MedPar database, we examined a total of 250,317 asymptomatic CEA operations in 2,302 hospitals and 13,701 symptomatic CEA operations in 1,851 hospitals. Even after stratifying CEA based on patient symptomatic status, significant Medicare payment variation was seen across both asymptomatic (1.9 fold) and symptomatic (3.7 fold) groups. In the symptomatic group, hospital payment variation was nearly double the amount seen in the asymptomatic group. Similarly, DRG, readmission payments and post-discharge payments were the highest contributors to the variation between low and high payment quintiles in both asymptomatic vs. symptomatic groups. Not surprisingly, the largest driver of payment appears to be post-operative stroke. Additionally, LOS and readmissions were independent predictors for increased payments for both asymptomatic and symptomatic patients undergoing CEA even after accounting for post-operative stroke.

Drivers of Variation

Although CEA is one of the most well-established, common, and low-morbidity vascular surgery operations, there is considerable variation in payments. Since this procedure is performed in high volumes across the country and has significant payment variation despite relatively low complication rates, it may represent an easy target for alternative payment strategies or bundled payment. The findings of this study highlight the importance of identifying the sources of variation in payments. The most significant contributors to this variation were DRG, post-discharge and readmission payments. DRG payments not only comprise the largest proportion of Medicare payments, but also represent a significant source of variation.

Post-discharge payments total 46.33% of payment variation in symptomatic CEA – making it the largest contributor to variation in symptomatic cases. While post-discharge payments also varied in the asymptomatic group, it comprised a much lower proportion of the total payment variation – 24.95%. When breaking down the payments further, we saw that significant variation in skilled nursing facility (SNF) payments and rehabilitation payments – all of which are expected to be higher in symptomatic CEA cases. Furthermore, discharge to skilled nursing or rehabilitation facilities has been shown to be associated with increased complications, readmissions and mortality.¹⁸ Therefore, these patients are presumably sicker, higher risk, and thus require much more intensive nursing and facility-related resources, making their stays more costly. However, as described by Eslami et al, even uncomplicated patients, admitted to nursing facilities, are much higher risk than patients discharged home. This is due to high adverse outcomes and readmissions.¹⁹

Readmission payments are another large contributor to the overall Medicare payment variation in both asymptomatic and symptomatic patients undergoing CEA. This was not

surprising given the current daily cost of hospitalization. Although readmission is not as common as lower extremity revascularization, CEA still have a readmission rate ranging from 8.5% to 9.6%.^{20,21} Recent studies have investigated predictors of readmission for vascular surgery patients undergoing procedures for critical limb ischemia and CEA and both found similar comorbid conditions that we found in our high payment quintile hospitals.^{20,22} These included CHF, diabetes, COPD and chronic kidney disease, which are important to incorporate and account for when formulating the episode bundled payment model for CEA.

Independent predictors of high payment hospitals

Multivariable analysis revealed stroke to be the most influential independent predictor of a high payment hospital. As would be expected, stroke is associated with longer length of stay and need for post-discharge care (rehabilitation and nursing care). Additionally, length of stay and readmissions were also independently associated with high payment hospitals in asymptomatic patients while additional predictors included yearly volume and complications in symptomatic patients. This is consistent with current literature. Both Duwayri and Abbott et al describe high cost of readmissions following vascular operations.^{23,24} Furthermore, Sternbergh et al observed higher cost in symptomatic patients compared to asymptomatic patients, and attributed these differences to higher LOS and more extensive imaging resource utilization.²⁵ For asymptomatic patients comorbidity burden and yearly volume were not associated with higher payment. This may be because at these centers they have efficient protocols followed by the care teams for CEA in uncomplicated patients and choose to send the more complex patients to tertiary centers.

Implications for clinical care, quality improvement, change in practice

With increased scrutiny from CMS and other payers, we need to ensure moving forward that there is accurate stratification of patients, which have high comorbidity burden. Although CEA is not yet in a bundled payment model, it may be one of the first vascular surgery operations included. Our data demonstrates a significant variation in payments that could potentially save the healthcare system money but at the same time could adversely affect the hospitals that treat more complex patients. Ellimooti and colleagues recently found a discrepancy between the payment a hospital would receive with and without risk adjustment (currently not taken into consideration in the bundled payment model) after lower extremity joint replacement.¹³

Additional concerns raised by Nathan et al, about the bundled payment system include ignoring the number and severity of patient's comorbid conditions. Additionally, the bundled payment will include 90 days following surgery with a majority of that time being for post-discharge care. As we have shown, post-discharge care is one of the main contributors to the variation seen after CEA, although this care is usually not connected with the hospital such as a local, non-hospital based, community skilled nurse facility that the procedure occurred at and thus this penalizes the hospital performing the surgery for cost incurred once the patients care is out of their control.²⁶ Regardless this data does highlight areas for improvement and reduction in the cost of care even among patients undergoing elective CEA for asymptomatic carotid stenosis. LOS was greater than 3 days in the highest payment

quintile. Limiting length of stay following elective CEA could yield significant lower costs for both the hospital and payments from Medicare. Recent energy to reduce readmissions would also provide an excellent target for cost reductions. Similarly, efforts to improve quality and reduce complications would yield significant savings.

Limitations

Our study has a few important limitations. First, we examine payments as a surrogate for cost. Unfortunately, one barrier that has been identified to reducing cost of care in our system is the lack of transparency that exists for cost in general with current methods of pricing and discounting.⁴ Secondly, in our dataset we are unable to examine preoperative payment variation, however this was recently examined by Chan et al, where they found a wide variation in practice pattern and resource utilization in Southern California Vascular Outcomes Improvement Collaborative including increased preoperative cardiac stress testing and completion imaging suggesting our results are underestimating the total variation.²⁷ Additionally, our cohort examines only the Medicare population and does not include patients with Medicaid or private insurance, however in a recent study by Obeid et al, they found that 75.7% of asymptomatic and 73.9% of symptomatic patients were covered under Medicare.²⁸ This suggests that this dataset is likely to capture the majority of CEAs performed in the United States. Our study also has the limitation of being a retrospective study evaluating patients in the Medicare population. Finally, given the lack of granularity present in the MedPar dataset, we are unable to examine clinical variables, which could affect payment, including the use of intraoperative monitoring during CEA, disease severity and operative details such as a reoperative field or a high bifurcation. Although these granular details are extremely important, CMS is also blind to these details and payment decisions will likely exclude this level of detail.

CONCLUSIONS

Carotid endarterectomy Medicare payments vary nationwide. With DRG, readmission and post-discharge payments being the largest contributors to overall payment variation. Stroke was the most influential independent predictor of stroke regardless of symptomatic status. In addition, LOS and readmission were the only independent predictors of higher payment for both asymptomatic and symptomatic patients undergoing CEA. Yearly volume and serious complications were only seen as independent predictors of high payment for symptomatic patients. The variation seen after this commonly performed vascular surgery suggests that within a bundled payment model there could be considerable cost savings for the health system especially within ensuring best practices to decrease LOS and readmissions. Moving forward, attention to symptomatic status and comorbidity burden of the patients will be imperative to incorporate into legislation.

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Figure 1. Flow Diagram Demonstrating the Number of Asymptomatic and Symptomatic Carotid Endarterectomies with the Associated Number of Hospitals
aCEA, asymptomatic carotid endarterectomy; sCEA, symptomatic carotid endarterectomy.

Figure 2.

A. Total and Component Payments by Medicare Payment Quintiles in Asymptomatic Patients Undergoing Carotid Endarterectomy.

B. Total and Component Payments by Medicare Payment Quintiles in Symptomatic Patients Undergoing Carotid Endarterectomy.

Table 1

Component Payment breakdown by hospital payment quintile.

	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	% total payment change	Ratio of Q5: Q1
Asymptomatic CEA							
N	461	460	461	460	460	--	--
DRG	5,732	6,247	6,386	6,641	7,929	32.44	1.38x
Outlier	8	33	47	91	366	5.29	45.75x
Readmission	295	576	750	917	1,693	20.64	6.39x
Physician	1,079	1,364	1,553	1,726	2,210	16.70	2.05x
Post-discharge	205	477	641	858	1,895	24.95	9.24x
Total payment	7,319	8,697	9,377	10,234	14,092	--	1.93x
Symptomatic CEA							
N	371	370	370	370	370	--	--
DRG	6,183	7,958	8,869	9,339	10,687	20.80	1.73x
Outlier	11	76	191	430	1,435	6.58	130.45x
Readmission	147	613	833	1,365	2,979	13.08	20.27x
Physician	1,375	2,033	2,402	2,982	4,237	13.22	3.08x
Post-discharge	267	1,422	3,149	5,103	10,299	46.33	38.57x
Total payment	7,984	12,103	15,445	19,220	29,638	--	3.71x

DRG, diagnosis related group; Q1, Quintile 1; Q5, Quintile 5.

Table II

Patient characteristics: demographics and comorbidities for patients in low payment quintile (Quintile 1) hospitals versus high payment quintile (Quintile 5) hospitals.

	<i>Asymptomatic CEA</i>			<i>Symptomatic CEA</i>		
	Low payment hospital N=32,314 No. (%)	High payment hospital N=27,626 No. (%)	<i>P</i> value	Low payment hospital N=1,330 No. (%)	High payment hospital N=1,936 No. (%)	<i>P</i> value
Patient demographics						
Age $\pm$ SD ^a	74.67 $\pm$ 7.46	74.59 $\pm$ 7.18	.186	74.51 $\pm$ 7.82	75.69 $\pm$ 8.16	< .001
Sex (male)	18,732 (57.97)	15,387 (55.70)	< .001	808 (60.75)	1,132 (58.47)	.192
Race (non-white)	1,867 (5.80)	2,953 (10.73)	< .001	148 (11.15)	282 (14.60)	.004
Comorbidities						
Obesity	2,057 (6.37)	2,026 (7.33)	< .001	103 (7.74)	121 (6.25)	.097
Hypertension	26,011 (80.49)	23,032 (83.37)	< .001	1,116 (83.91)	1,559 (80.53)	.014
CHF	1,754 (5.43)	2,305 (8.34)	< .001	79 (5.94)	247 (12.76)	< .001
DM, uncomplicated	8,905 (27.56)	8,374 (30.31)	< .001	(28.42)	573 (29.60)	.467
DM, complicated	1,304 (4.04)	981 (3.55)	.002	64 (4.81)	96 (4.96)	.849
COPD	6,619 (20.48)	6,558 (23.74)	< .001	241 (18.12)	405 (20.92)	.048
Renal Failure	3,109 (9.62)	3,131 (11.33)	< .001	141 (10.60)	308 (15.91)	< .001
PVD	6,130 (18.97)	6,620 (22.66)	< .001	232 (17.44)	327 (16.89)	.680
Elixhauser $\pm$ SD ^a	2.12 $\pm$ 1.33	2.46 $\pm$ 1.46	< .001	2.26 $\pm$ 1.32	2.67 $\pm$ 1.53	< .001
Operative characteristics						
Yearly volume $\pm$ SD ^a	55.03 $\pm$ 42.85	41.11 $\pm$ 33.13	< .001	1.97 $\pm$ 1.59	2.77 $\pm$ 2.22	< .001

^aSD indicates continuous variables with summary measure of mean (standard deviation) and *P* value from Student's *t*-test. Categorical variables are summarized by No. (%), and *P* values are calculated from the χ^2 test. CHF, congestive heart failure; DM, diabetes; BMI, body mass index.

Table III

Post-operative characteristics: Incidence of complications for patients in low payment quintile hospitals vs. high payment quintile hospitals.

	Asymptomatic CEA			Symptomatic CEA		
	Low payment hospital N=32,313 % $\pm$ SD	High payment hospital N=27,625 % $\pm$ SD	P value	Low payment hospital N=1,330 % $\pm$ SD	High payment hospital N=1,934 % $\pm$ SD	P value
Death	0.76 $\pm$.07	0.78 $\pm$.11	< .001	2.48 $\pm$.02	2.49 $\pm$.04	< .001
Stroke	0.50 $\pm$.73	1.46 $\pm$ 2.11		1.20 $\pm$.16	5.17 $\pm$.27	< .001
MI	0.01 $\pm$.19	0.03 $\pm$.88	< .001	0.06 $\pm$ 1.56	0.97 $\pm$ 7.25	< .001
Any complication	4.59 $\pm$ 2.66	10.25 $\pm$ 5.02	< .001	6.32 $\pm$ 10.56	24.02 $\pm$ 19.72	< .001
Serious complication	2.05 $\pm$ 14.17	6.96 $\pm$ 25.44	< .001	4.81 $\pm$ 21.41	22.68 $\pm$ 20.81	< .001
Specific Complication						
Pneumonia	0.00 $\pm$.18	0.03 $\pm$ 1.29	< .001	0.06 $\pm$.99	0.15 $\pm$ 6.82	< .001
Respiratory failure	0.01 $\pm$.59	0.06 $\pm$ 1.41	< .001	0.12 $\pm$ 1.80	1.45 $\pm$ 7.14	< .001
DVT/PE	0.00 $\pm$.02	0.00 $\pm$.17	.0014	0	.13 $\pm$ 2.51	.065
Acute renal failure	0.01 $\pm$.22	0.10 $\pm$ 1.57	< .001	0.73 $\pm$ 6.00	2.08 $\pm$ 8.99	< .001
Hemodialysis	0.03 $\pm$.47	0.07 $\pm$ 1.34	< .001	0.51 $\pm$ 4.45	1.08 $\pm$ 7.13	.010
SSI	0.00 $\pm$.02	0.00 $\pm$.23	.007	0.02 $\pm$.49	0.04 $\pm$.80	.271
GI bleed	0.00 $\pm$.05	0.00 $\pm$.20	< .001	0.02 $\pm$.32	0.21 $\pm$ 3.10	.023
Shock	0.00 $\pm$.08	0.02 $\pm$.93	< .001	0.07 $\pm$ 1.30	0.29 $\pm$ 3.29	.020
Sepsis	0.00 $\pm$.08	0.01 $\pm$.64	.008	0	0.27 $\pm$ 2.52	< .001
LOS (d)	1.75 $\pm$ 1.98	3.16 $\pm$ 3.88	< .001	4.31 $\pm$ 3.63	9.07 $\pm$ 8.78	< .001
Readmission (30d)	6.02 $\pm$ 23.79	11.37 $\pm$ 31.74	< .001	4.14 $\pm$ 19.92	26.08 $\pm$ 24.13	< .001

All values represent incidence rates of the specified complication per hospital. Rates are summarized by % $\pm$ standard deviation (SD) and *P* values are from Student's *t*-test. CAD, coronary artery disease; MI, myocardial infarction; DVT/PE, deep vein thrombosis/pulmonary embolism; SSI, surgical site infection; GI, gastrointestinal; LOS, length of stay; d, days.

Table IV

Independent predictors of increased payment among asymptomatic patients undergoing CEA. N = 921 hospitals.

	OR (95% CI)	P value
Patient Factors		
Age	1.00 (0.99 – 1.00)	.145
Race (White)	0.67 (0.55 – 0.82)	< .001
Elixhauser	1.11 (1.07 – 1.15)	< .001
Operative Factors		
Yearly volume	0.99 (0.98 – 1.00)	.049
Post-Operative Factors		
Stroke	1.34 e ³⁹ (4.79e ²⁷ – 3.76e ⁵⁰)	< .001
Serious complications	0.83 (0.70 – 0.99)	.035
LOS	1.23 (1.19 – 1.27)	< .001
Readmission (30d)	1.53 (1.42 – 1.64)	< .001

Multivariable logistic regression with high payment (quintile 5) hospitals as the outcome variable. All covariates included in the model are summarized with odds ratios (OR) and 95% confidence intervals (CI). *P* values are from Wald test in logistic regression. LOS, length of stay.

Table V

Independent predictors of increased payment among symptomatic patients undergoing CEA. N = 741 hospitals.

	OR (95% CI)	P value
Patient Factors		
Age	1.01 (1.00 – 1.02)	.162
Race (White)	0.95 (0.70 – 1.29)	.726
Elixhauser	1.04 (0.97 – 1.11)	.320
Operative Factors		
Yearly volume	1.28 (1.09 – 1.50)	.003
Post-Operative Factors		
Stroke	3,375 (25.82 - 441,094.20)	.001
Serious complications	2.00 (1.47 – 2.73)	< .001
LOS	1.23 (1.18 – 1.27)	< .001
Readmission (30d)	5.94 (4.34 – 8.13)	< .001

Multivariable logistic regression with high payment (quintile 5) hospitals as the outcome variable. All covariates included in the model are summarized with odds ratios (OR) and 95% confidence intervals (CI). *P* values are from Wald test in logistic regression. LOS, length of stay.