

## A Nationwide Analysis of Cost Variation for Cerebral Aneurysm Treatment

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### Introduction

Improving resolution of diagnostic imaging allows for increased detection of symptomatic and incidental unruptured aneurysms. Despite a relatively low annual rupture risk, the high rate of mortality from subarachnoid hemorrhage leads neurosurgeons to encourage treatment for unruptured cerebral aneurysms.

Goal: To examine the underlying causes of geographic and inter-hospital variations between clipping and coiling of unruptured cerebral aneurysms using two national databases.

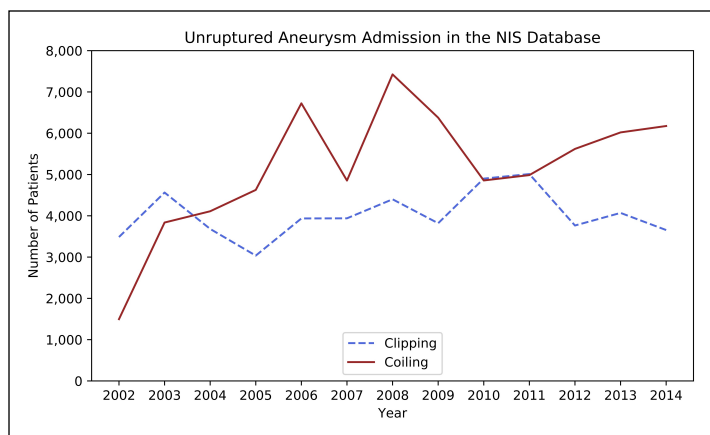
### Methods

**Data source and population:** 24,171 adult unruptured aneurysm patients who were treated via clipping or coiling in the National Inpatient Sample (NIS) 2002-2014. Using the same criteria, we found 11,205 patients in the Vizient database 2013-2015.

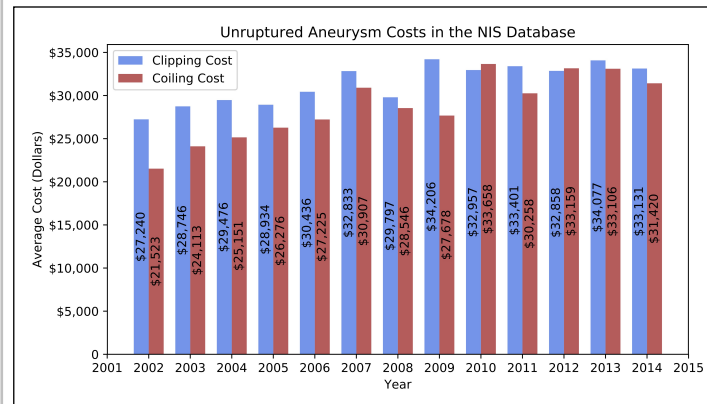
**Statistical analysis:** All costs were adjusted for inflation to 2014 US dollars. We performed survey-weighted univariate and multivariate analyses (gamma distribution and log transformation). All coefficients in our multiplicative model correspond to percent changes in cost. For example,  $coefficient=1.08$  indicates that costs are 8% higher than the reference group.

### Results

Treatment pattern of aneurysms between 2002-2014

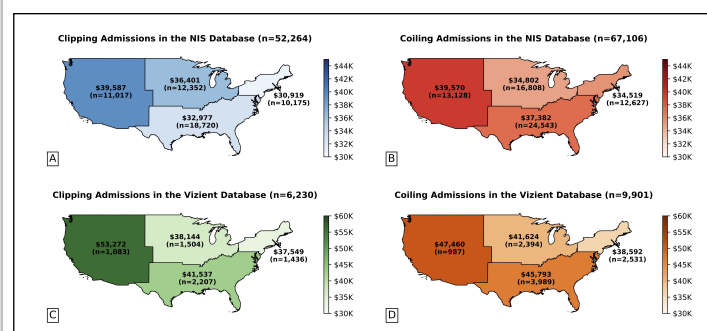


### Results



In the NIS database between 2002 and 2014,

- Clipping costs increased 22% while coiling costs increased 46%.
- Coiling patients were more likely to have shorter length of stay, non-elective status, and lower risk of mortality than clipping patients (all  $P<0.001$ ).
- Multivariate analyses showed length of stay, number of comorbidities, risk of mortality, and hospital location in the western United States were associated with higher costs for clipping and coiling (all  $P<0.05$ ).



In the Vizient database between 2013 and 2015,

- Clipping costs increased 18%, while coiling increased 7% between 2013 and 2015
- Multivariate analyses confirmed that the western United States was the most expensive region for clipping and coiling ( $P<0.05$ ).

### Results

	Unruptured Clipping Coefficient	P-value	Unruptured Coiling Coefficient	P-value
NIS Database				
Age, in increments of 10 years	0.98	0.001	1.01	0.042
Sex (Female vs. Male)	0.98	0.047	0.96	0.002
Race (vs. White)				
Black	1.07	<0.001	0.98	0.246
Hispanic	1.02	0.221	0.94	0.026
Other	1.04	0.062	1.07	0.034
Insurance Status (vs. Private)				
Medicare	1.00	0.735	0.98	0.233
Medicaid	1.01	0.478	0.99	0.599
Other	1.01	0.487	1.06	0.009
LOS, in days	1.05	<0.001	1.05	<0.001
Number of comorbidities, in increments of 1	1.02	<0.001	1.03	<0.001
Risk of Mortality (vs. Minor)				
Moderate	1.23	<0.001	1.03	0.065
Major/Extreme	1.34	<0.001	1.15	<0.001
Elective Status (Elective vs. Non-elective)	0.93	<0.001	0.95	0.017
Wage Index, in increments of 0.1	1.06	<0.001	1.02	0.078
Hospital Location and Teaching Status (vs. Rural)				
Urban Non-Teaching	0.79	0.001	0.83	0.048
Urban Teaching	0.87	0.052	0.81	0.004
Hospital Bed Size (vs. Small)				
Medium	0.94	0.282	1.03	0.766
Large	0.90	0.025	1.03	0.713
Hospital Region (vs. Northeast)				
Midwest	1.18	<0.001	1.00	0.861
South	1.07	0.123	1.08	0.066
West	1.28	<0.001	1.15	0.004
Vizient Database				
CMI	1.03	<0.001	1.20	<0.001
LOS, in days	1.04	<0.001	1.04	<0.001
ICU stay, in days	1.05	<0.001	1.01	0.006
Bed size (vs. Small)				
Medium	1.01	0.448	1.12	<0.001
Large	1.25	<0.001	1.01	0.779
Volume (vs. Small)				
Medium	0.94	<0.001	0.87	<0.001
Large	0.84	<0.001	1.00	0.864
Hospital region (vs. Northeast)				
Midwest	1.02	0.172	1.08	<0.001
South	1.11	<0.001	1.19	<0.001
West	1.42	<0.001	1.23	<0.001

### Conclusions

There is a significant increase and large variation in costs for treatment of unruptured aneurysms. In our analysis of two separate national databases, hospitals in the West had significantly higher costs, even after controlling for patient and hospital factors.

### Acknowledgements

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