



GEOGRAPHIC VARIATION SERIES. This Close-Up is part of a comprehensive set of reports that examine the rates at which certain procedures are delivered in different communities across the state. These procedures may be considered elective. They include cardiac procedures, carotid endarterectomy, hip and knee replacement, cancer and spinal procedures, hysterectomy, childbirth procedures, and gallbladder surgery. A research summary, "All Over the Map: Elective Procedure Rates in California Vary Widely," provides additional information on regional variation and a complete methodology for the study.¹

Based on patients' place of residence, the data are from 2005 through 2012, and have been divided into two time periods for purposes of comparison over time. Rates can vary widely, even in contiguous communities. The data account for age, sex, income, education, insurance status, and race. The data are adjusted at the Zip code level for rates of AMI (heart attack) hospitalization and rates of hospitalizations in which the patient had a diabetes diagnosis.

Carotid Endarterectomy in California: A Close-Up of Geographic Variation

The carotid arteries supply blood to the brain. These arteries can develop fatty deposits, known as plaque. These plaques can rupture, causing a blood clot to move into the arteries in the brain and block the flow of blood, leading to a stroke or a transient ischemic attack (TIA), which is a temporary interruption of blood flow to the brain.

Treatment choices for plaque buildup in the carotid arteries include:

- ▶ Medications to reduce the risk of clots and to control high blood pressure and cholesterol
- ▶ Carotid endarterectomy to remove the plaque
- ▶ Carotid artery stenting to open blocked arteries and keep them open with a mesh metal tube called a stent

Treatment is intended to reduce the risk of future stroke or TIA. Some patients choose to lower their risk of TIA and stroke by taking medicine to control their blood pressure and cholesterol and thus lower the risk of blood clots. Quitting smoking and getting regular physical exercise can also lower the risk of stroke. Specific medicines may have risks and side effects.

Carotid endarterectomy is a surgery whereby a small incision is made in the neck to expose the carotid artery. Blood flow is temporarily rerouted, as the artery is opened and plaque is removed. The hospital stay is usually one to three days, and there may be some aching for up to two weeks.

The patients most likely to benefit from this procedure are those who have had symptoms of TIA or a stroke in the past six months and those who have plaque blocking 70% of at least one artery. The risk for stroke, death, or heart attack as a result of carotid endarterectomy is 5.2%. If the patient has not had a stroke or TIA, or if less than half the artery is blocked, the immediate risks of the surgery outweigh any potential long-term benefits.

There are other risks of carotid endarterectomy that vary depending on the patient. The most serious risks include heart and breathing problems, high blood pressure, bleeding in the brain, nerve injury, infection, and plaque buildup.

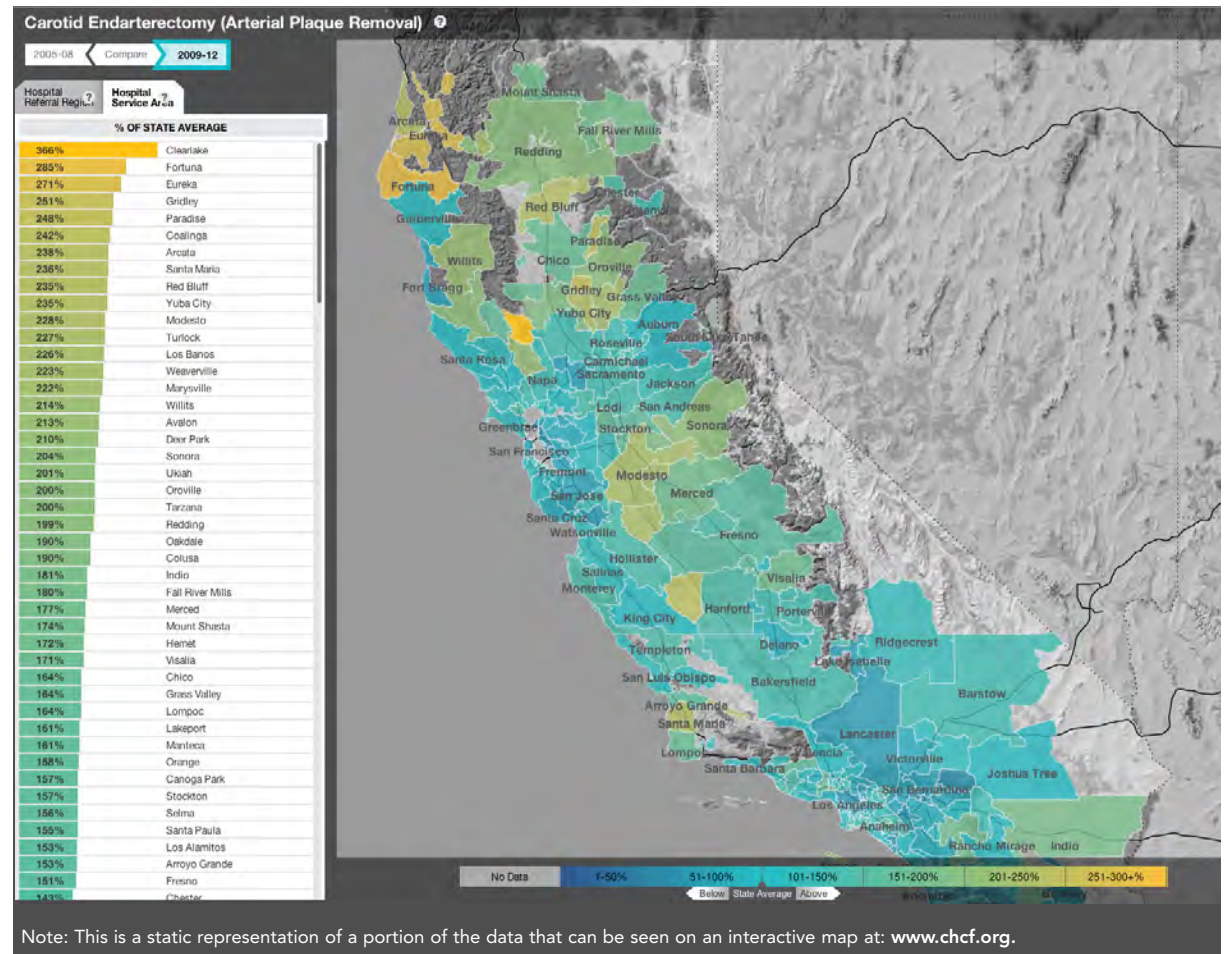
Carotid artery stenting refers to the process of threading a stent, or wire mesh tube, up an artery in the groin to the carotid arteries. A balloon enlarges

the narrowed part of the artery, and the stent keeps the artery open. Stents can be as effective as carotid endarterectomy in reducing the risk of future stroke or TIA. But carotid stenting itself can cause a stroke in about 7.7% of patients. About 8.5% will suffer stroke, death, or heart attack as a result of the stenting. Like carotid endarterectomy, the benefits of surgery may be outweighed by the risks unless the patient is at high risk of stroke without it.

Only 15% of all strokes are due to carotid artery disease. Heart, lung, and kidney disease as well as diabetes can also contribute to the risk of stroke, and carotid surgery does not reduce the risk from these causes.²

Residents of some hospital service areas (HSAs) undergo carotid endarterectomy at much higher or much lower rates than those in other HSAs.³ State averages should not be taken as the correct or “right” rate for elective procedures; they are used only as the comparator for analysis, not as a benchmark. There is no recommended baseline for elective procedures. See Figure 1.

Figure 1. Geographic Variation in Carotid Endarterectomy, California, 2009-12



The high and low extremes by HSA are shown in Figure 2 for both data-collection periods, 2005-08 and 2009-12.

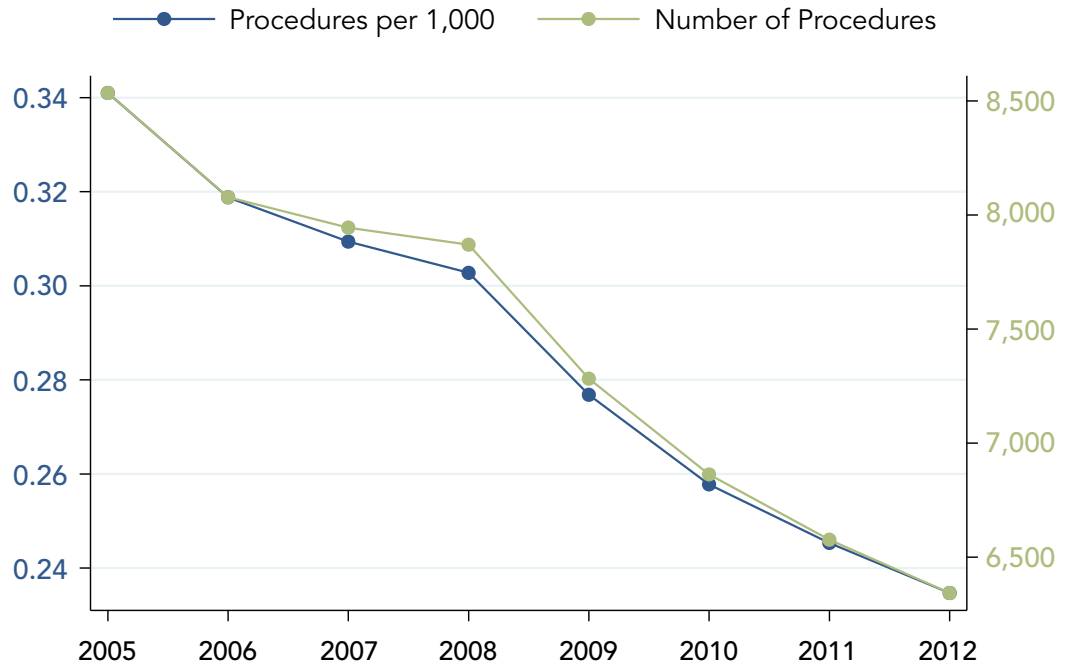
Figure 2. Carotid Endarterectomy, 10 Lowest and Highest HSAs, 2005-08 and 2009-12

2005-08		2009-12	
10 Lowest HSAs, adjusted rate per 1,000			
Lake Isabella	0.14	Fontana	0.12
Pasadena	0.15	San Pablo	0.15
Coronado	0.15	Big Bear Lake	0.15
Downey	0.17	Downey	0.15
Poway	0.17	Alameda	0.15
King City	0.18	Oakland	0.16
Paramount	0.19	Hawthorne	0.16
Los Angeles	0.20	La Jolla	0.16
Oakland	0.20	Berkeley	0.16
Chino	0.20	Laguna Hills	0.16
10 Highest HSAs, adjusted rate per 1,000			
Modesto	0.67	Yuba City	0.59
Paradise	0.69	Red Bluff	0.60
Arcata	0.69	Santa Maria	0.60
Fortuna	0.69	Arcata	0.60
Oroville	0.70	Coalinga	0.61
Gridley	0.70	Paradise	0.63
Yuba City	0.71	Gridley	0.64
Lompoc	0.74	Eureka	0.69
Clearlake	0.81	Fortuna	0.72
Santa Maria	0.86	Clearlake	0.93

Since 2005, carotid endarterectomy procedures, adjusted for population, have dropped significantly,

from a rate of 0.34 procedures per 1,000 population to 0.24 per 1,000. See Figure 3.

Figure 3. Carotid Endarterectomy, Statewide Trends in the Number and Rate of Procedures, 2005 to 2012



Procedures Chosen for the Study

Procedures studied were based on patient discharge data for carotid endarterectomy. This analysis controlled for age, sex, income, education, insurance status, and race, as well as rates of acute myocardial infarction (heart attack) and diabetes.

Authors

The original content of this report, published in September 2011, was developed by Vanessa Hurley, MPH, and Shannon Brownlee, MS. It was updated in November 2014.

About the Foundation

The California HealthCare Foundation works as a catalyst to fulfill the promise of better health care for all Californians. We support ideas and innovations that improve quality, increase efficiency, and lower the costs of care. For more information, visit us online at www.chcf.org.

Endnotes

1. The research for this report was developed by Laurence Baker, PhD, a consultant to this project and professor of health research and policy, and chief of health services research, Stanford University School of Medicine, in collaboration with Maryann O'Sullivan, JD, an independent health policy consultant. Analysis and interpretation of the estimates were performed by Frances Tompkins, data consultant. Lance Lang, MD, chaired an advisory committee of clinicians in various specialties, which was also consulted in the production of this report to review the analysis and to ensure the accuracy of medical content. For a complete list of advisory committee members, see the research summary "All Over the Map: Elective Procedure Rates in California Vary Widely," www.chcf.org. Data were obtained from the Office of Statewide Health Planning and Development.
2. This section was written using the following sources:
 - Shannon Brownlee et al., *Improving Patient Decision-Making in Health Care: A 2011 Dartmouth Atlas Report Highlighting Minnesota* (Lebanon, NH: Dartmouth Atlas Project, 2011).
 - "Stroke: Should I Have Carotid Endarterectomy?," Kaiser Permanente, accessed February 7, 2011, members.kaiserpermanente.org.
 - Kosmas Paraskevas et al., "Carotid Artery Stenting Compared with Endarterectomy in Patients with Symptomatic Carotid Stenosis (International Carotid Stenting Study): An Interim Analysis of a Randomized Controlled Trial," *The Lancet* 375, no. 9719 (July 31, 2010): 985-997, doi:10.1016/S0140-6736(10)60239-5. (Note: the rates of stroke, heart attack, and death for endarterectomy and stenting reflect rates up to 120 days following the procedure.)
3. HSAs represent a local health care market for community-based inpatient care. HSAs can include more than one community.