



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

Geographic Variation Series. This Close-Up is part of a comprehensive set of reports that examine the rates at which 13 elective procedures are delivered in different communities across the state. They include cardiac procedures, carotid endarterectomy, hip and knee replacement, mastectomy, hysterectomy, childbirth procedures, gallbladder surgery, and weight loss surgery. A research summary, "All Over the Map: Elective Procedure Rates in California Vary Widely," provides additional background information on the topic of regional variation and a complete methodology for the study.¹

The data are from 2005 through 2009 and are based on patients' place of residence. Rates can vary widely, even in contiguous communities. The data account for age, sex, income, education, insurance status, and race. In the case of carotid endarterectomy, 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.

THE CAROTID ARTERIES SUPPLY BLOOD TO the brain. These arteries can develop fatty deposits, known as plaque. These plaques can sometimes 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

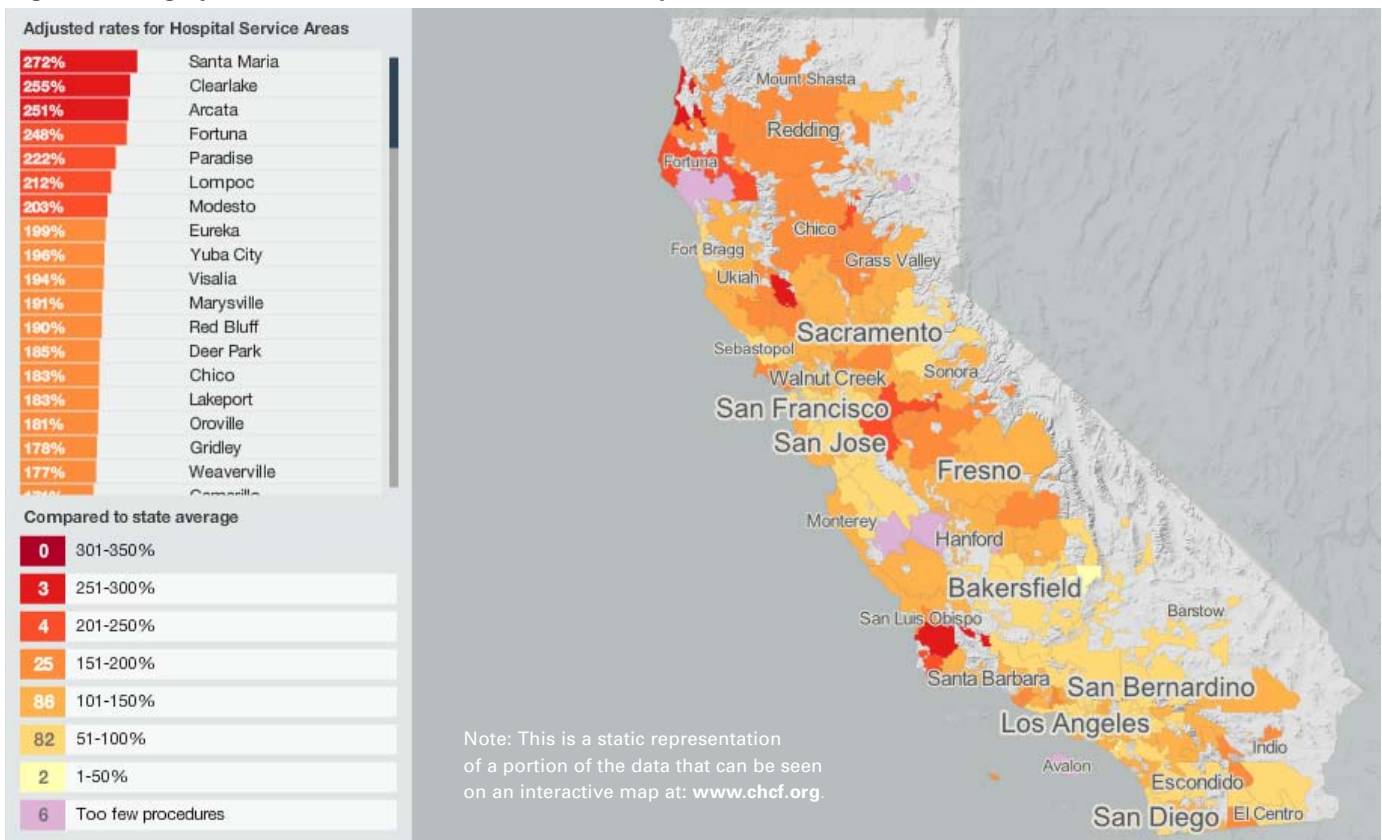
CLOSE-UP

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 HSAs undergo carotid endarterectomy at much higher or much lower rates than those in other HSAs.³ See Figure 1.

Figure 1. Geographic Variation in Carotid Endarterectomy, California, 2005–2009



DATA VARIATION ANALYSES

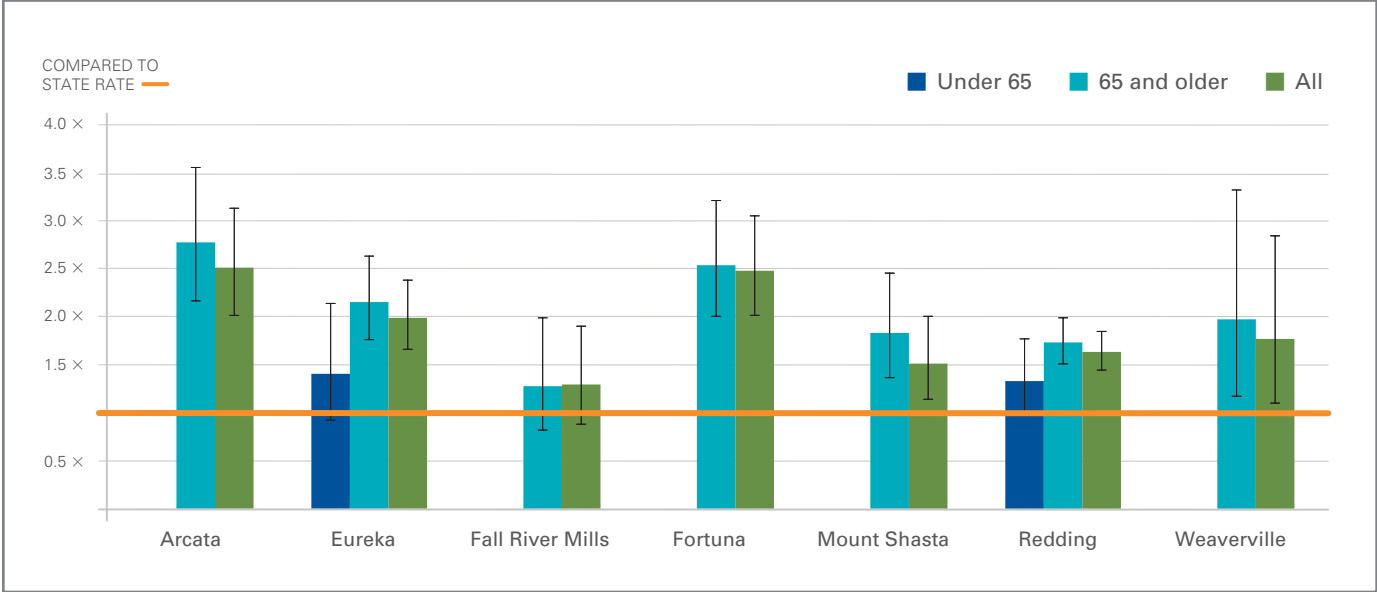
- Residents of Santa Maria HSA (Santa Barbara HRR) are at least four times as likely to undergo carotid endarterectomy as residents of Laguna Hills HSA (Orange HRR).
- Residents of Clearlake HSA (Napa HRR) are at least three times as likely to undergo carotid endarterectomy as residents of Chino HSA (San Bernardino HRR).
- Residents of Modesto HSA (Modesto HRR) are at least two and a half times as likely to undergo carotid endarterectomy as residents of Los Angeles HSA (Los Angeles HRR).
- Residents of Fortuna HSA (Redding HRR) are at least two and a half times as likely to undergo carotid endarterectomy as residents of Poway HSA (San Diego HRR).

DEFINITIONS: **Hospital service areas (HSAs)** represent a local health care market for community-based inpatient care. HSAs can include more than one community. **Hospital referral regions (HRRs)** represent a health care market for tertiary medical care. (A tertiary designation is based on where patients receive major cardiovascular surgical procedures and neurosurgery.) Each HRR includes at least one HSA that has a hospital or hospitals that perform major cardiovascular procedures or neurosurgery.

In four of seven Redding HSAs, residents 65 and older undergo carotid endarterectomy at more than one and a half times the state rate. In two of those four, Arcata HSA and Fortuna HSA, residents 65 and older undergo the procedure at more than twice the state rate. See Figure 2.

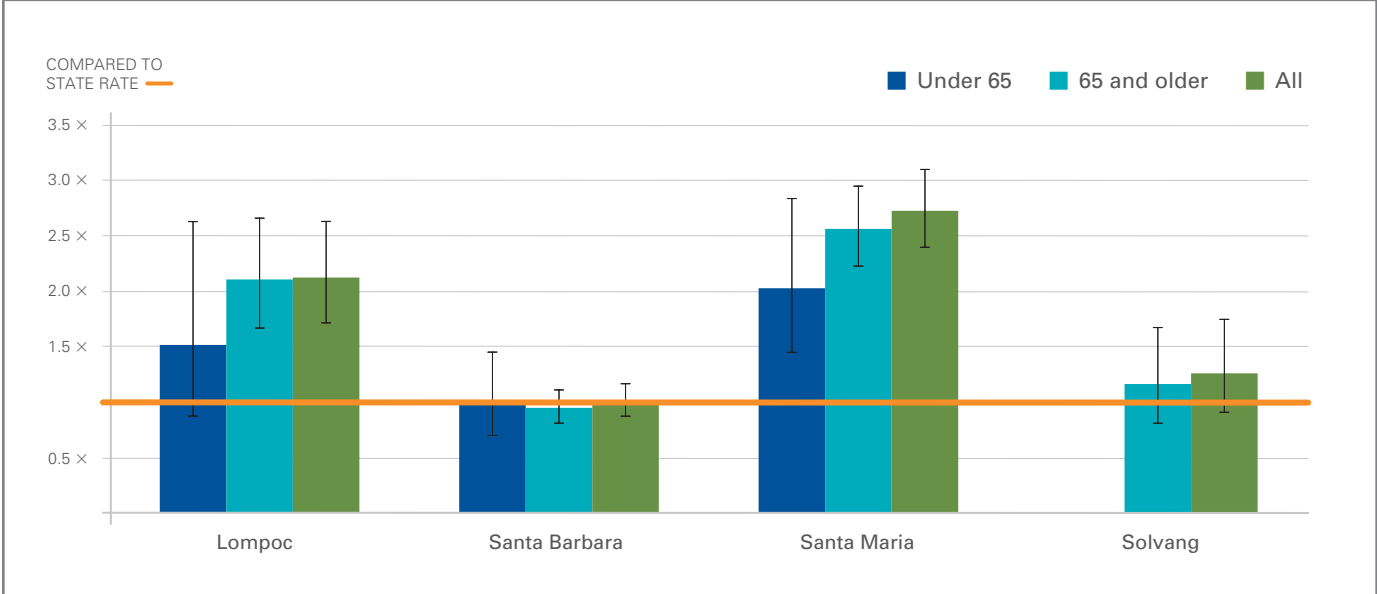
Note regarding Figures 2 and 3: The narrow vertical line at the top of each bar displays the range of the confidence intervals.

Figure 2. Carotid Endarterectomy, Redding HSAs Compared to State Rate, by Patient’s Age Group, 2005–2009



In two of four Santa Barbara HSAs, residents 65 and older undergo carotid endarterectomy at more than one and a half times the state rate. In one of those two, Santa Maria HSA, residents 65 and older undergo the procedure at more than twice the state rate. See Figure 3.

Figure 3. Carotid Endarterectomy, Santa Barbara HSAs Compared to State Rate, by Patient’s Age Group, 2005–2009



Note: Each dot in this graph represents the rate for a procedure in a single California HSA. Dots at the top and bottom of the graphs represent the extremes in rates. The narrower the graph, the greater the variation in rates across HSAs.

Figure 4. Carotid Endarterectomy, by HSA, 2005–2009

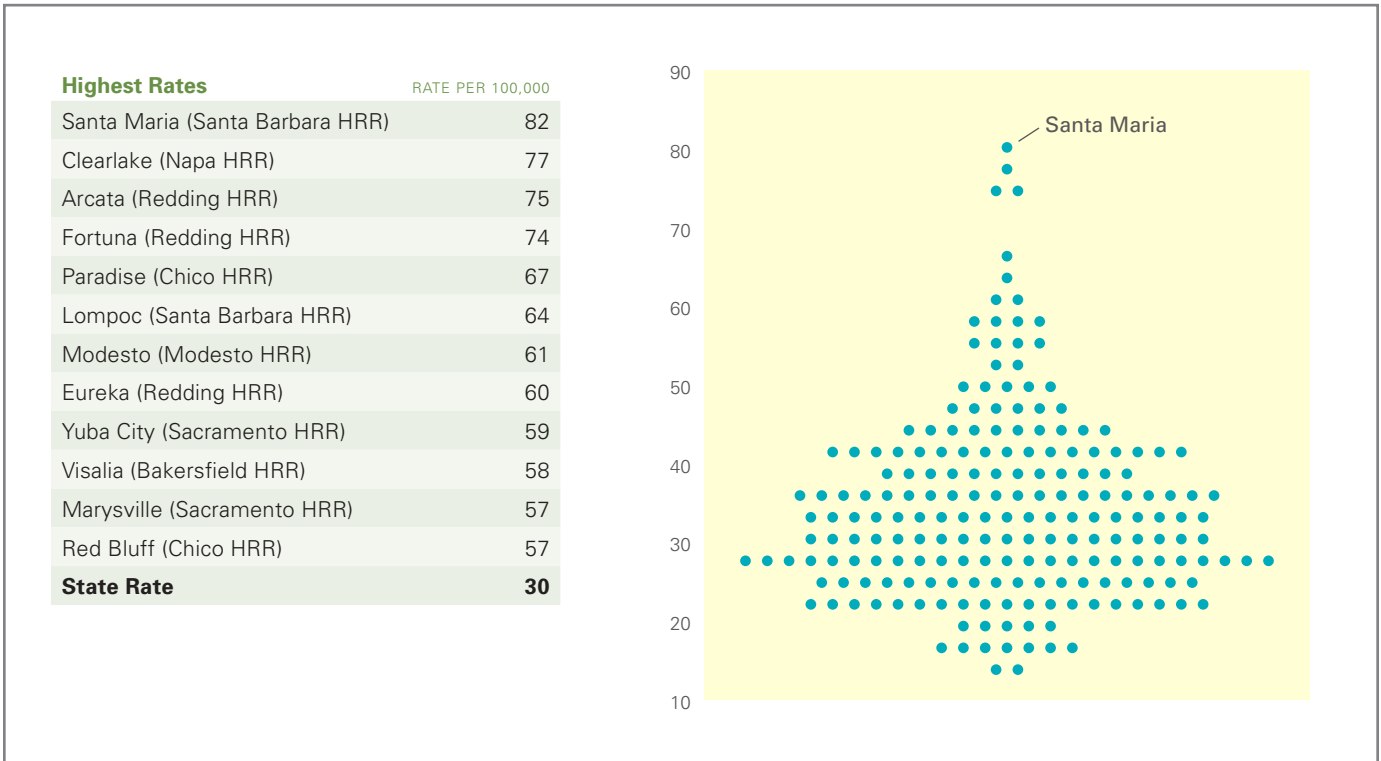


Table 1. Rates of Carotid Endarterectomy in California Hospital Service Areas (HSAs), 2005–2009

HOW TO USE THIS TABLE: In the Arcata HSA, residents undergo carotid endarterectomy at least 202% of the state rate (and at most 313%). That means they are at least twice as likely as the average Californian to undergo the procedure.

Notes: An HSA includes both the city for which it is named as well as surrounding areas. Confidence intervals describe a range and are listed in parentheses. For example, 57%–70% indicates that, with 95% confidence, the range of possible values spans from 57% to 70% of the state rate. Blank cells indicate insufficient data.

LEGEND

- At least twice the state rate
- At least one and a half times the state rate

Carotid Endarterectomy		Carotid Endarterectomy		Carotid Endarterectomy	
Compared to state rate of 30 per 100,000		Compared to state rate of 30 per 100,000		Compared to state rate of 30 per 100,000	
California	100%	Castro Valley	83%	Encinitas	83%
Alameda	77%		(69% – 100%)		(67% – 102%)
	(57% – 103%)	Chester	102%	Encino	139%
Anaheim	112%		(62% – 168%)		(99% – 194%)
	(101% – 123%)	Chico	183%	Escondido	95%
Antioch	100%		(160% – 210%)		(82% – 111%)
	(86% – 116%)	Chino	53%	Eureka	199%
Apple Valley	92%		(42% – 68%)		(166% – 238%)
	(77% – 111%)	Chula Vista	97%	Fairfield	104%
Arcadia	81%		(85% – 111%)		(84% – 128%)
	(70% – 94%)	Clearlake	255%	Fall River Mills	130%
Arcata	251%		(210% – 310%)		(88% – 190%)
	(202% – 313%)	Coalinga		Fallbrook	110%
Arroyo Grande	155%				(86% – 142%)
	(129% – 185%)	Colusa	137%	Folsom	117%
Auburn	122%		(93% – 202%)		(91% – 152%)
	(105% – 142%)	Concord	98%	Fontana	73%
Avalon			(83% – 115%)		(59% – 91%)
Bakersfield	73%	Corcoran		Fort Bragg	84%
	(66% – 80%)				(57% – 124%)
Banning	97%	Corona	88%	Fortuna	248%
	(80% – 117%)		(75% – 104%)		(202% – 305%)
Barstow	56%	Coronado	55%	Fountain Valley	96%
	(40% – 78%)		(33% – 92%)		(83% – 112%)
Bellflower	97%	Covina	122%	Fremont	95%
	(81% – 116%)		(104% – 145%)		(82% – 109%)
Berkeley	75%	Culver City	85%	Fresno	135%
	(59% – 95%)		(62% – 115%)		(125% – 147%)
Big Bear Lake	75%	Daly City	115%	Fullerton	108%
	(53% – 106%)		(98% – 136%)		(97% – 121%)
Brawley	81%	Davis	139%	Garberville	135%
	(57% – 114%)		(111% – 175%)		(76% – 240%)
Burbank	111%	Deer Park	185%	Garden Grove	102%
	(100% – 123%)		(145% – 235%)		(82% – 127%)
Burlingame	138%	Delano	75%	Gardena	111%
	(118% – 161%)		(52% – 107%)		(83% – 149%)
Camarillo	171%	Dinuba	142%	Gilroy	89%
	(147% – 198%)		(96% – 210%)		(66% – 122%)
Canoga Park	169%	Downey	55%	Glendale	70%
	(152% – 186%)		(46% – 66%)		(62% – 78%)
Carmichael	124%	Duarte	92%	Glendora	116%
	(111% – 138%)		(63% – 135%)		(98% – 138%)
		El Centro	84%		
			(66% – 106%)		

Carotid Endarterectomy

Compared to state rate
of 30 per 100,000

Granada Hills	115% (91% – 145%)
Grass Valley	117% (98% – 140%)
Greenbrae	156% (138% – 177%)
Greenville	
Gridley	178% (128% – 248%)
Hanford	106% (88% – 127%)
Harbor City	121% (105% – 140%)
Hawthorne	111% (87% – 142%)
Hayward	107% (90% – 126%)
Healdsburg	169% (130% – 219%)
Hemet	138% (123% – 154%)
Hollister	80% (59% – 109%)
Huntington Beach	109% (93% – 128%)
Indio	150% (126% – 180%)
Inglewood	68% (56% – 82%)
Irvine	84% (65% – 109%)
Jackson	120% (98% – 146%)
Joshua Tree	134% (111% – 161%)
King City	
La Jolla	82% (67% – 99%)
La Mesa	104% (95% – 114%)
Laguna Hills	49% (40% – 61%)
Lake Isabella	42% (26% – 66%)
Lakeport	183% (151% – 222%)
Lakewood	123% (93% – 162%)

Carotid Endarterectomy

Compared to state rate
of 30 per 100,000

Lancaster	88% (77% – 99%)
Lindsay	138% (89% – 214%)
Livermore	84% (66% – 107%)
Lodi	157% (139% – 177%)
Loma Linda	59% (44% – 79%)
Lompoc	212% (171% – 263%)
Long Beach	124% (113% – 135%)
Los Alamitos	149% (130% – 171%)
Los Angeles	66% (60% – 71%)
Los Banos	139% (105% – 186%)
Lynwood	79% (66% – 94%)
Madera	133% (107% – 166%)
Manteca	114% (95% – 137%)
Martinez	93% (71% – 121%)
Marysville	191% (159% – 229%)
Merced	170% (149% – 194%)
Mission Hills	92% (74% – 113%)
Mission Viejo	75% (64% – 89%)
Modesto	203% (189% – 218%)
Montebello	98% (81% – 118%)
Monterey	132% (114% – 154%)
Monterey Park	73% (54% – 98%)
Morgan Hill	112% (82% – 153%)
Mount Shasta	151% (114% – 201%)

Carotid Endarterectomy

Compared to state rate
of 30 per 100,000

Mountain View	92% (78% – 109%)
Napa	150% (130% – 173%)
National City	100% (77% – 131%)
Newport Beach	102% (91% – 115%)
Northridge	145% (127% – 166%)
Norwalk	79% (63% – 99%)
Novato	131% (106% – 162%)
Oakdale	137% (108% – 174%)
Oakland	72% (62% – 85%)
Oceanside	115% (103% – 127%)
Ojai	121% (89% – 164%)
Orange	152% (131% – 175%)
Oroville	181% (154% – 213%)
Oxnard	161% (140% – 186%)
Palm Springs	120% (104% – 139%)
Panorama City	90% (74% – 109%)
Paradise	222% (190% – 261%)
Paramount	76% (51% – 113%)
Pasadena	57% (47% – 69%)
Petaluma	99% (80% – 122%)
Pinole	70% (54% – 92%)
Pittsburg	91% (71% – 117%)
Placerville	97% (82% – 114%)
Pleasanton	81% (64% – 102%)

Carotid Endarterectomy

Compared to state rate
of 30 per 100,000

Pomona	75% (64% – 87%)
Porterville	139% (114% – 170%)
Poway	58% (48% – 71%)
Rancho Mirage	121% (108% – 135%)
Red Bluff	190% (156% – 232%)
Redding	164% (145% – 185%)
Redlands	102% (88% – 119%)
Redwood City	105% (89% – 122%)
Ridgecrest	76% (54% – 107%)
Riverside	89% (80% – 98%)
Roseville	123% (109% – 138%)
Sacramento	129% (120% – 140%)
Salinas	97% (81% – 115%)
San Andreas	91% (73% – 115%)
San Bernardino	69% (60% – 79%)
San Clemente	108% (86% – 136%)
San Diego	77% (71% – 84%)
San Dimas	89% (65% – 120%)
San Francisco	94% (84% – 106%)
San Gabriel	72% (59% – 87%)
San Jose	94% (86% – 102%)
San Leandro	100% (82% – 121%)
San Luis Obispo	115% (97% – 137%)
San Mateo	132% (114% – 154%)

Carotid Endarterectomy

Compared to state rate
of 30 per 100,000

San Pablo	63% (49% – 80%)
San Pedro	129% (107% – 155%)
San Ramon	65% (44% – 97%)
Santa Ana	128% (112% – 147%)
Santa Barbara	101% (87% – 116%)
Santa Cruz	115% (97% – 137%)
Santa Maria	272% (239% – 309%)
Santa Monica	95% (84% – 108%)
Santa Paula	137% (106% – 177%)
Santa Rosa	107% (96% – 120%)
Sebastopol	81% (58% – 112%)
Selma	143% (111% – 184%)
Simi Valley	139% (120% – 161%)
Solvang	126% (90% – 174%)
Sonoma	106% (82% – 137%)
Sonora	150% (127% – 176%)
South El Monte	98% (66% – 146%)
South Laguna	86% (71% – 104%)
South San Francisco	123% (99% – 152%)
Stanford	91% (73% – 114%)
Stockton	149% (135% – 165%)
Sun City	106% (91% – 125%)
Tarzana	159% (134% – 189%)
Templeton	118% (98% – 143%)

Carotid Endarterectomy

Compared to state rate
of 30 per 100,000

Thousand Oaks	118% (100% – 140%)
Torrance	122% (111% – 135%)
Tracy	84% (64% – 110%)
Tulare	134% (109% – 166%)
Turlock	156% (135% – 181%)
Ukiah	148% (118% – 186%)
Upland	76% (67% – 86%)
Vacaville	130% (108% – 156%)
Valencia	92% (80% – 106%)
Vallejo	139% (118% – 163%)
Van Nuys	139% (122% – 158%)
Ventura	138% (119% – 159%)
Victorville	77% (66% – 89%)
Visalia	194% (172% – 220%)
Walnut Creek	108% (96% – 122%)
Watsonville	70% (49% – 99%)
Weaverville	177% (110% – 285%)
West Covina	114% (99% – 130%)
Whittier	93% (83% – 106%)
Wildomar/Murrieta	99% (86% – 114%)
Willits	113% (79% – 162%)
Woodland	131% (107% – 161%)
Yuba City	196% (166% – 231%)

PROCEDURES CHOSEN FOR THE STUDY

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

AUTHORS

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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, of Stanford University, in collaboration with Maryann O’Sullivan, JD, and the staff and leadership of the Campaign for Effective Patient Care. Analysis and interpretation of the estimates were performed by Frances Tompkins, former project assistant, and O’Sullivan, former executive director, of the Campaign for Effective Patient Care, in consultation with Shannon Brownlee, MS, acting director of the New America Foundation Health Policy Program. 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. 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.