HHS Public Access

Author manuscript

Ann Vasc Surg. Author manuscript; available in PMC 2015 August 13.

Published in final edited form as:

Ann Vasc Surg. 2014 May ; 28(4): 887–892. doi:10.1016/j.avsg.2013.08.016.

Carotid Endarterectomy National Trends Over A Decade: Does gender matter?

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Abstract

Introduction—The objective is to evaluate among hospitalized men and women with carotid disease if there is a difference in timing of in-hospital carotid endarterectomy (CEA) or outcomes of CEA based on gender.

Methods—Retrospective cross-sectional study utilizing the Nationwide Inpatient Sample Database. All patients from 2000-2009 who underwent carotid endarterectomy during their hospitalization were examined. ICD-9 codes were used to identify patients who underwent CEA during hospitalization, stratify asymptomatic and symptomatic patients, determine time in days from admission to carotid endarterectomy, and examine in-hospital complications including perioperative stroke, cardiac events, and death. Statistical analysis was performed with chi-square and t-tests. Linear and logistic regression models were used to evaluate relationships between gender and outcomes. Main outcome measures were time from admission to surgery, in-hospital mortality, complications, mean length of stay (LOS), and discharge disposition.

Results—221,253 patients underwent CEA during hospitalization. 9.2% had symptomatic carotid disease. Among symptomatic patients, on bivariate analysis women had a longer mean time from admission to surgery (2.8 vs. 2.6 days, $p < .001$), and a longer length of hospitalization (6.4 vs. 5.9 days, $p < .001$) than their male counterparts on bivariate analysis. However, there was no difference between men and women in rates of perioperative stroke, cardiac complications, myocardial infarction, or death. Among asymptomatic patients, women had a longer mean time from admission to surgery (0.53 v. 0.48 days, $p < .001$) and a trend toward increased perioperative stroke (0.6% vs. 0.5%, p=.06); but a lower rate of cardiac complications (1.5% vs. 1.7%, $p = .01$)

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and in-hospital mortality (0.26% vs. 0.31%, p = .05). However, on multivariable analysis adjusting for differences in age, elective status, insurance, race, hospital location, hospital region, and hospital teaching status, there was no gender disparity in time from admission to surgery, regardless of symptomatic status. In addition, asymptomatic women were less likely than men to have a cardiac complication (OR 0.90, CI 0.83-0.97) or in-hospital mortality (OR 0.83, CI 0.70-0.98). Symptomatic women were also less likely than men to have a cardiac complication (OR 0.78, CI 0.63-0.97).

Conclusions—In this national population based study of hospitalized patients undergoing CEA over a decade, women have lower perioperative cardiac morbidity and mortality rates than men. After adjusting for patient, clinical and hospital factors, there is no discernible difference in timing of CEA based on gender.

Introduction

There is a lack of consensus on the outcomes of carotid endarterectomy in women. The published data on differences between men and women in outcomes following carotid endarterectomy (CEA) are mixed. Subgroup analysis of the North American Symptomatic Carotid Endarterectomy Trial (NASCET), Asymptomatic Carotid Atherosclerosis Study (ACAS), and European Carotid Surgery Trial (ECST) suggested that CEA may not be as efficacious in women as it is in men.[1,2,3,4,5] However, since these seminal trials numerous studies and systematic reviews have shown conflicting results regarding a gender disparity in outcomes following CEA.[6,7,8,9,10,11] These conflicting findings have the potential to influence medical practice, but there is a paucity of data examining if gender disparity exists the treatment of carotid stenosis. A study of patients diagnosed with carotid stenosis in the Kaiser Health care system found that women with carotid stenosis are less likely than their male counterparts to undergo CEA and, of those who do go on to surgery, women experience a longer time from initial diagnosis to the time of surgery.[15] In addition, it has been demonstrated that there is a gender disparity in the cardiovascular care of patients, with women experiencing significant delays in the treatment of myocardial infarction.[12] Therefore, the aims of this study are to determine if among hospitalized patients with carotid disease, (1) do women experience a longer time from admission to CEA and (2) if there is a difference in timing of CEA, does this lead to a gender based difference in short term outcomes following CEA.

Methods

This was a retrospective cross-sectional analysis of hospital discharge data for 2000-2009 from the Health Care Utilization Project-Nationwide Inpatient Sample (HCUP-NIS) database, which is a stratified 20% sample of all inpatient admissions to nonfederal, acute care hospitals maintained by the Agency for Healthcare Research and Quality (AHRQ). It is the largest all-payer inpatient database in the U.S., with records from approximately eight million hospital stays each year. This study received exemption from the Institutional Review Board at our institution because data were de-identified.

Records were limited to adults hospitalized with carotid stenosis, as identified utilizing the ICD 9 code based AHRQ HCUP NIS Clinical Classification Software codes 109 - 110.[13,14]

ICD-9 procedure codes were used to abstract all patients who underwent carotid endarterectomy (ICD 9 code 38.12) as the primary procedure during hospitalization.

Independent Variables

Gender was the primary independent variable of interest. Patient-level covariates included age and race/ethnicity (white, black, Hispanic, other, as coded in HCUP-NIS). Clinical covariates included admission urgency (elective vs. non-elective) and insurance status (private, Medicaid, Medicare, self-pay). Hospital level variables included hospital location, region and teaching status. Patients were stratified as asymptomatic or symptomatic using ICD-9 codes as previously described in other studies examining symptomatic carotid disease.[15]

Outcome Variables

Outcomes of interest were: (1) time from admission to procedure (in days); (2) in-hospital mortality; (3) perioperative stroke; (4) myocardial infarction; (5) perioperative cardiac complications; (6) mean length of hospital stay (LOS); and (7) discharge disposition (routine discharge to home, or non-routine discharge to home with home health care or discharge to a short term hospital, intermediate care facility, or skilled nursing facility).

Complications were categorized as perioperative stroke, myocardial infarction or perioperative cardiac complications, and identified by ICD-9 codes.

Statistical Analysis

Bivariate analysis of the independent variables by outcomes was performed using χ^2 tests for categorical variables and analysis of variance (ANOVA) for continuous variables. Multivariable linear regression was used to model continuous outcomes (time to procedure and LOS), Multivariable logistic regression was used to model in-hospital mortality, discharge disposition, and complication rates. Data analysis and management were performed using SAS version 9.1 (Cary, NC, USA). Statistical significance was set at a probability value of $p \leq .05$.

Results

Among the 221,253 adults who underwent carotid endarterectomy for carotid stenosis in the HCUP-NIS database during the 10 year period from 2000-2009, 9.2% (n=20,370) of patients had symptomatic carotid disease. The mean age for symptomatic patients was 70.2 years for men and 70.85 years for women. Among symptomatic patients, 41.47% of women had an elective admission compared with 43.64% of men. The mean age for asymptomatic patients was 71 years for both men and women. Among asymptomatic women, 84.63% of women had an elective admission, compared with 84.92% of men. On bivariate analysis, the time from hospital admission to carotid endarterectomy was significantly longer for women than men, regardless of symptomatic or asymptomatic status (Table 1). Women also had a significantly longer length of stay than men, regardless of symptomatic status. However,

asymptomatic men were significantly more likely than their female counterparts to have a surgical cardiac complication.

On multivariable analysis adjusting for differences in age, elective status, insurance, race, hospital location, hospital region, and hospital teaching status, women did not experience a significant difference in time from admission to surgery, regardless of symptomatic status (Table 2). However, women had significantly higher odds of post-discharge admission to a facility or need for home health supportive care. Unexpectedly, women had lower odds of having a surgical cardiac complication than men, with an even wider gender disparity among symptomatic patients.

Discussion

Previous studies have suggested that there is a difference in current practice in the care of women and men with carotid artery stenosis. For example, the American Vascular Association National Screening Program performed screening for carotid disease in older Americans at high risk for atherosclerosis and found that among patients with carotid artery stenosis, there was a significant gender disparity in appropriate medical management of patients with carotid stenosis. Women were much less likely than men to be taking anti-platelet medications (32% vs. 58%, p=0.0006).[16] This difference in anti-platelet therapy between women and men was also observed in the Netherlands among patients who underwent CEA, with women being significantly less likely than their male counterparts to be on aspirin.[17]

Some studies have suggested that women experience either a delay in surgery or lower rate of surgical intervention. Poisson et al. identified 299 patients diagnosed in emergency departments in California with high grade symptomatic carotid stenosis, and found women with severe carotid stenosis and recent TIA were less likely to undergo CEA than men (36.4% vs. 53.8%, p=0.004), independent of other clinical factors. Among those women who did undergo CEA, time to surgery was significantly delayed compared with men (mean 35 days vs. 18 days, p=0.03).[18] Amaranto et al. examined 253 CEAs at their institutions and found that only 41% of women compared with 52.7% of men with treatable carotid artery disease underwent carotid endarterectomy, but this was not statistically significant.[19]

To our knowledge, our study is the first nationwide study to describe whether women experience a delay from admission to CEA. We found no gender based disparity in time from admission to surgery. However, the timing from pre-hospital diagnosis of carotid stenosis to surgery cannot be captured in the HCUP-NIS database. Treatment delays prior to admission are important determinants of outcome but we are unable to assess any pre-hospitalization factors in our study. We also found that men had higher risk for a perioperative cardiac complication or in-hospital mortality. In contrast, women were more likely to require post-discharge home health supportive care or post-discharge admission to a facility. Discharge to an institutional care facility rather than home has been associated with a four-fold increase in one-year mortality.[20] Our study found that a large proportion of female patients required home health care support, nursing home or facility care, which may portend patient loss of independence and increased risk for post-discharge mortality.

Although we adjusted for differences in patient demographics measured in HCUP-NIS (age, race/ethnicity, insurance status), the HCUP-NIS database does not report other social determinants, such as smoking which can affect cardiovascular disease or marital status, which could potentially affect post-hospitalization discharge disposition.

This study also adds to the growing body of literature examining the influence of gender and timing of treatment of cardiovascular disease. Levy et al. demonstrated that women do not wait longer than men for elective coronary artery bypass surgery.[21] Gan et al. showed though women received less aggressive treatment during the early management of an acute myocardial infarction, there is no effect on early mortality.[22] Poisson et al demonstrated in their regional study of patients in the Kaiser Permanente Health System patients in California that women with severe carotid stenosis and recent TIA experienced significantly longer pre-hospitalization time from diagnosis to surgery than their male counterparts (35 days vs. 18 days, p=0.03)[15] However, this study was limited by the small sample size of 299 patients. Though we are unable to examine pre-hospital factors in our study, we were able to demonstrate in a large national sample of patients treated at all-payer hospitals over a decade that a gender disparity does not exist in the timing of surgery during the their hospitalization for carotid stenosis.

There are other limitations inherent to any administrative database such as HCUP-NIS. There can be coding errors leading to missed diagnoses and procedures, as well as lack of coding leading to missing data. HCUP-NIS is a well-validated and rigorously maintained database, and its coding error rate has been low.[23] Operative details are not available in HCUP-NIS. Readmissions and post-discharge mortality are not captured; therefore, it is likely that the study underestimates perioperative morbidity and mortality. HCUP-NIS does not capture degree of carotid stenosis, whether the patient was optimally medically managed with antiplatelet therapy and statins, or whether they are smokers, which are all important factors affecting outcomes. This is a significant limitation as multiple studies have delineated that the risk benefit ratio of CEA versus medical management is dependent on the degree of carotid stenosis.[1,2,3] The HCUP NIS does not include a Charlson Comorbidity score as one of the data elements in the dataset. In addition, symptomatic status can be under-captured in this administrative database. We did not examine whether patients had a combined CEA CABG procedure or whether patients with heart disease might be less likely to undergo CEA, which could affect outcomes such as rates of cardiac complications following CEA. We are unable to examine pre-admission variables such as when the patient was initially diagnosed because HCUP NIS only examines single hospital admissions. This is a significant limitation that we are not able to incorporate into our analysis. However, the only other study to examine this question of whether there is a gender disparity in timing of CEA looking at patients seen in emergency departments in a single payer system (Kaiser) in a particular region of California, which are factors which can also affect outcome. Our study, despite the limitation of data examining only in-hospital outcomes, is a national study that incorporates all payers in the US, and has a sample size of several hundred thousand patients.

Summary

In summary, this is the first nationwide study to examine whether women experience a delay from admission to CEA during their hospitalization. After adjusting for patient and hospital level variables, women do not experience a longer time from admission to CEA during their admission. Unexpectedly, women had lower odds of having a surgical cardiac complication than men, with an even wider gender disparity among symptomatic patients. More data are needed, including data regarding effect of degree of stenosis on time from presentation to CEA, and its effect on outcomes in women compared with men. The management of women with carotid stenosis requires optimization of medical therapy, as well as recognition that women are more likely than men to require post discharge home health supportive care or discharge to a facility. Optimizing their care requires multi-disciplinary collaboration among primary care physicians key in enabling optimization of medical therapy, emergency room physicians, perioperative teams, and surgeons.

Acknowledgments

This work was previously presented at the Midwest Vascular Surgery 2012 conference on September 6, 2012 and at the Society for Vascular Surgery 2013 conference poster session on May 31, 2013. The data acquisition for this project was initially funded by the Robert Wood Johnson Clinical Scholars Program at Yale University School of Medicine. This study is supported, in part, by grant 1UL1RR031973 from the Clinical and Translational Science Award (CTSI) program of the National Center for Research Resources, National Institutes of Health.

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Table 1

Differences in Symptomatic and Asymptomatic Patients Undergoing Carotid Endarterectomy in the United States, 2000-2009

	Symptomatic Patients			Asymptomatic Patients		
	Men	**Women**	**P value**	**Men**	**Women**	**P value**
Number (n = 221,253)	12,112	8,254	--	114,737	86,150	--
Time to surgery (days)	2.20 d	2.77 d	< .001	0.48 d	0.53 d	< .001
Length of stay (days)	5.87 d	6.43 d	< .001	2.31 d	2.55 d	< .001
Perioperative stroke (%)	5.52%	5.94%	0.21	0.49 %	0.55 %	0.06
Myocardial infarction (%)	1.44%	1.61%	0.34	0.84 %	0.89 %	0.27
Perioperative cardiac complication (%)	1.90%	1.56%	0.07	1.67 %	1.52 %	0.01
Died (%)	1.72%	1.92%	0.30	0.31 %	0.26 %	0.05

Legend: n = number, d = days.

Ann Vasc Surg. Author manuscript; available in PMC 2015 August 13.

Table 2

Gender and Carotid Endarterectomy Outcomes, 2000-2009*

	Death	Time to Procedure	Perioperative Stroke	Myocardial Infarction	Surgical Cardiac Complications	Length of Stay (days)	Discharge to Facility or Home Health
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Asymptomatic							
Male	1	1	1	1	1	1	1
Female	0.83 (0.70-0.98)	NS	NS	NS	0.90 (0.83-0.97)	0.93 (0.92-0.93)	1.26 (1.20-1.33)
Symptomatic							
Male	1	1	1	1	1	1	1
Female	NS	NS	NS	NS	0.78 (0.63-0.97)	0.92 (0.90-0.95)	1.18 (1.10-1.28)

Legend:

NS = Not significant

*Adjusted for age, emergency surgery, insurance status, race, hospital location, hospital region, hospital teaching status;