Outcomes of Carotid Endarterectomy in the Elderly
Report From the National Cardiovascular Data Registry

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Background and Purpose—Benchmark trials of carotid endarterectomy often did not include elderly patients, and the results may not be easily extrapolated to the general population. Using the Carotid Artery Revascularization and Endarterectomy registry, we sought to determine real-world outcomes of carotid endarterectomy in the elderly.

Methods—This was a retrospective cohort study of patients aged >70 years. We compared outcomes stratified by age among symptomatic and asymptomatic patients.

Results—There were 4149 patients who underwent carotid endarterectomy; 1376 (33.1%) were symptomatic. Overall mortality rate was 0.5%. The primary outcome of in-hospital death, stroke, and myocardial infarction showed a significant trend and was highest in the age >85 years group (5.6%). Among symptomatic patients, mortality and the primary outcome were not statistically different between those aged >75 years and those aged 70 to 74 years. Among asymptomatic elderly patients, mortality rate was significantly higher in age group >75 years compared with <75 years (0.7% vs 0.0%); however, the combined outcome of stroke, death, and myocardial infarction was not statistically different.

Conclusions—Elderly patients >85 years of age were at increased risk for death or perioperative complications of stroke, death, and myocardial infarction compared with those who were relatively younger. More elderly patients underwent carotid endarterectomy for asymptomatic carotid stenosis and had higher mortality than the younger counterparts, underlining need for caution in subjecting them to the procedure. (Stroke. 2013;44:1172-1174.)

Key Words: Carotid Artery Revascularization and Endarterectomy registry ■ carotid endarterectomy ■ National Cardiovascular Data Registry ■ elderly patients

Risks of carotid endarterectomy (CEA) among the elderly need to be accurately determined. Administrative databases1 and systematic reviews2 show that CEA performed in elderly patients has increased perioperative morbidity and mortality. North American Symptomatic Carotid Endarterectomy Trial 70% to 99% phase and Asymptomatic Carotid Atherosclerosis Study systematically excluded patients >80 years.3,4 Case series describe perioperative risks in the elderly to be comparable with those in younger patients.5,6 The Carotid Artery Revascularization and Endarterectomy (CARE) registry is uniquely positioned to analyze real-world clinical practice and patient outcomes of CEA in a manner useful to physicians, administrators, payers, and patients. We evaluated effect of age as well as symptomatic status on perioperative outcomes of elderly patients undergoing CEA.

Materials and Methods
The CARE registry is operated by the National Cardiovascular Data Registry (NCDR), a voluntary, hospital-based, prospective, clinical procedures registry.7 There are standard data definitions and collection protocols, and data dictionary.8 The complete set of CARE Registry definitions can be found at https://www.ncdr.com/webncdr/care/. We included patients aged >70 years who underwent CEA from January 2005 to March 2011. The primary outcome was a composite of in-hospital stroke, death, and myocardial infarction (MI). We grouped age into 4 categories: 70 to 74, 75 to 79, 80 to 84, and ≥85, and compared outcomes and clinical characteristics using either the linear trend test (continuous) or the Mantel–Haenszel trend test (Table 1). The effect of age was evaluated in an adjusted logistic regression model predicting the primary outcome. Outcomes were also stratified based on whether the patients underwent CEA for symptomatic or asymptomatic carotid stenosis. Probability values of 0.05 (2-tailed) were considered to indicate statistical significance.

Results
The primary outcome (stroke, death, and MI) was seen in 2.9% of elderly patients, with increasing risk across the age groups, which was statistically significant for trend (P=0.003). The overall mortality rate was 0.5%, and it was highest in the >85 years group at 1.7%. There was a statistically significant trend across the various age groups (P=0.002). In symptomatic patients, the combined risk of death, stroke, and MI was higher in the age ≥75 years group (3.5%) compared with the age 70 to 74 years group (2.8%), but not statistically different (P=0.472). In asymptomatic patients, mortality was significantly higher in the age >75 group compared with the age 70 to 74 years group (0.7%...
vs 0.0%; \( P=0.006 \), and the combined risk of death, stroke, and MI was 3.1% in the age >75 years group compared with 2.0% in the age 70 to <74 years group (\( P=0.08; \) Table 2). The adjusted odds ratio of the combined outcome of stroke, death, and MI was 2.26 in the age >85 years group compared with the age 70 to 74 years group, which was statistically significant (95% confidence interval, 1.27–4.2; Figure).

### Discussion

In the CARE Registry, we found significant differences in perioperative mortality within groups of elderly patients undergoing CEA. This was in spite of the fact that the risk of MI or perioperative stroke or transient ischemic attack was not significantly higher in those aged >85 years. Thus, the higher mortality was likely related, at least in part, to complications other than stroke and MI. Stroke risk factors, including diabetes mellitus, smoking status, and dyslipidemia, were less prevalent in older groups. In spite of the potential advantage, they had higher mortality and risk of the combined outcome of stroke, death, and MI.

The worse outcomes in the patients aged >85 years are mostly attributable to worse outcomes in asymptomatic group. There was significantly higher mortality among asymptomatic patients undergoing CEA in those age >85 years compared with those in the age 70 to 74 years group. By some estimates, >90% of patients undergoing CEA in the United States are asymptomatic patients in spite of national guidelines recommending CEA only in highly selected patients. This trend is reflected in the CARE Registry, in which far more CEA procedures were performed for asymptomatic patients.

Strengths of this study are as follows: (1) a robust national sample from 171 hospitals; (2) prospectively collected data with rigorous attention to detail; and (3) contrary to randomized clinical studies in which the inclusion and exclusion were stringent, our study is more reflective of contemporary practice. This analysis represents a good estimate of the real-world outcomes of the CEA procedure in elderly.
Limitations
CARE registry does not include all US hospitals that perform CEA. The primary end point (stroke, death, and MI) in our study was lower than some randomized studies, such as CREST, in which the combined risk of stroke, death, and MI among patients aged >75 years undergoing CEA was 5.9%. This could, in part, be because the primary outcome we chose was in-hospital, whereas randomized studies have 30-day events. There was also no standardized method to determine degree of carotid stenosis.

Conclusions
The majority of CEA procedures in patients aged >70 years reported in the CARE registry are performed for asymptomatic stenosis. CEA should be carefully weighed in asymptomatic patients, especially when they are older. Overall, the perioperative risk of complications after CEA in the elderly is within widely accepted guidelines. There are significantly higher rates of the composite of stroke, MI, and death with increasing age >70 years, for patients undergoing CEA.

Disclosures
The study was supported by American College of Cardiology Foundation’s National Cardiovascular Data Registry (NCDR). Views expressed are those of the author(s) and do not necessarily represent the official views of the NCDR or its associated professional societies. Dr Spertus has a contract from American College of Cardiology Foundation to analyze the Carotid Artery Revascularization and Endarterectomy registry. Dr Chaturvedi is a consultant for Abbot Vascular and Thornhill Research. Dr Ruggiero is consultant for St. Jude and Boston Scientific.

References
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