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Surgical specialty and outcomes for carotid endarterectomy: evidence from the National Surgical Quality Improvement Program

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ABSTRACT

Background: Carotid endarterectomy (CEA) has been performed since the 1950s and remains one of the most common surgical procedures in the United States. The procedure is performed by cardiothoracic, general, neurologic, and vascular surgeons. This study uses data from the National Surgical Quality Improvement Program (NSQIP) to examine the outcomes after CEA when performed by general or vascular surgeons.
Materials and methods: Data included 34,493 CEAs from years 2005 to 2010 recorded in the NSQIP database. Primary outcomes measured were length of stay, 30-d mortality, surgical site infection, cerebrovascular accident, myocardial infarction, and blood transfusion requirement. Secondary outcomes measured were the remaining intraoperative outcomes from the NSQIP database.
Results: After controlling for patient and surgical characteristics, patients treated by general surgeons did not have a significantly different LOS or 30-d mortality than those treated by vascular surgeons. Patients of general surgeons had nearly twice the risk of acquiring a surgical site infection (odds ratio [OR] = 1.94; $P = 0.012$), >1.5 times the risk of cerebrovascular accident (OR = 1.56; $P = 0.008$), and >1.8 times the risk of blood transfusion (OR = 1.85; $P = 0.017$) than those of vascular surgeons. Patients of general surgeons had less than half the risk of having a myocardial infarction (OR = 0.34; $P = 0.031$) than those of vascular surgeons.
Conclusions: Surgical specialty is associated with a wide range of postoperative outcomes after CEA. Additional research is needed to explore practice and cultural differences across surgical specialty that may lead to outcome differences.

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1. Introduction

In the United States, cerebrovascular disease accounts for nearly 130,000 deaths annually and is the fourth leading cause of death [1]. The large majority of strokes are ischemic in origin and as many of 20% of those are due to atherosclerotic disease of the carotid artery [2]. Although there are various methods of treating carotid artery stenosis, carotid endarterectomy (CEA) is considered the standard of care and remains the most frequently performed surgical procedure to prevent stroke [3,4]. CEA has been performed since the 1950s; however, since the publication of the North American Symptomatic Carotid Endarterectomy Trial [5], the European Carotid Surgery Trial [6], and the Asymptomatic Carotid Atherosclerosis Study [7] in the early 1990s, the number of procedures performed in the United States has markedly increased [4].

Numerous reports on outcomes emphasizing perioperative mortality and stroke after CEA have been published. Studies have been conducted analyzing the effects of race, surgeon volume, hospital volume, shunting, intraoperative imaging, cerebral monitoring, as well as many other factors on CEA outcomes [8–11]. Investigations of the effect of surgical specialty on CEA outcomes have produced conflicting results. Some have reported no significant difference in effect of surgical specialty on outcomes [5,10,12,13] and others have demonstrated a significant effect of surgical specialty on outcomes for CEA [9,14–16]. Although Transient ischemic attack and stroke outcomes are included in some reports, there are many other outcomes associated with CEA that have not been as well studied. The purpose of this study was to examine the relationship between surgical specialty and outcomes from CEA using data from the American College of Surgeons private sector National Surgical Quality Improvement Program (NSQIP). This data set offers an opportunity to examine the effect of surgical specialty on a wide array of surgical outcomes, including hospital length of stay (LOS) and 30-d mortality, as well as surgical site infection (SSI), myocardial infarction (MI), cerebrovascular accident (CVA), blood transfusion requirement, and 11 other perioperative outcomes.

2. Methods

2.1. Data

CEA was identified as a primary procedure using current procedure terminology code of 35301. Patients with additional procedures performed at the time of CEA were not excluded *a priori*, but by considering CEA only as a principal procedure, cases where CEA was performed secondarily to a major procedure, such as coronary artery bypass graft surgery, were excluded. This process identified 34,493 CEAs performed between the years 2005 and 2010 from all participating institutions. These cases represent only a fraction of the total CEAs performed during these years since NSQIP only samples cases at participating hospitals and is not all inclusive. [17,18]. Most of these procedures were performed by vascular surgeons ($N = 32{,}848$) and general surgeons ($N = 1{,}645$). Analyses were stratified by these two surgical specialties.

All patient characteristic and outcome data were taken from the NSQIP database collected using standard NSQIP methodology [17,18]. Data were collected by a trained staff of surgical clinical nurse reviewers who worked in conjunction with the surgeon champion for accurate data collection. Uniformity was maintained through the use of an operation manual, which outlined data collection procedures and variable definitions, as well as routine conference calls, site visits, and annual meetings [19]. Surgeon specialty was assigned by the surgical clinical nurse reviewer using either the surgical service line most closely associated with the principal operative procedure or the surgeon's self-declared specialty [20]. For CEA, if a surgeon was board certified in both vascular and general surgery, the surgeon was considered a vascular surgeon [20].

Of the 60 patient characteristics collected for the NSQIP database, variables that had the greatest relevance to the CEA procedure were selected. Preoperative characteristics included age, sex, race/ethnicity, anesthesia type, American Society of Anesthesiologists (ASA) class, operation time, and comorbidities (Table 1). Age was divided into quartiles including 20–64, 65–74, 75–79, and 80+ years. Similarly, operation time, recorded in minutes, was divided into quartiles including <84, 85–109, 110–139, and 140+. Race/ethnicity was stratified by white (non-Hispanic), black (non-Hispanic), Hispanic (including all Hispanic ethnicities), and other (including all other races recorded in the database: American Indian, Alaska Native, Asian, Pacific Islander, Native Hawaiian, or unknown race not of Hispanic origin). Anesthesia type was divided into four categories, the most common anesthesia type being general ($N = 29{,}077$), followed by regional ($N = 3{,}709$), then monitored ($N = 1{,}372$), then all the other types ($N = 335$), including spinal, epidural, other, and no anesthesia. Most patients were rated at an ASA class 3 ($N = 26{,}801$) or class 4 ($N = 4{,}582$), with very few rated at class 1 ($N = 54$) or class 5 ($N = 12$). For statistical analyses, ASA class was divided into two categories, "1, 2, and 3" and "4 and 5." Comorbidities selected include diabetes, smoking, previous Percutaneous coronary intervention (PCI), previous previous cardiac surgery (PCS), hypertension requiring medication, and history of congestive heart failure (CHF), MI, angina, peripheral vascular disease (PVD), or CVA.

In addition to LOS, 30-d postoperative mortality, and any outcome variables, we selected four of NSQIP's 17 perioperative outcomes that were relevant to CEA: SSI, MI, CVA, and blood transfusion requirement. We also created two composite outcome variables. The first measured the incidence of any of the 17 intra- or postoperative outcomes of interest. These 17 outcomes included cardiac arrest, CVA, blood transfusion requirement, intubation lasting >48 h, failure of graft/prosthesis, wound dehiscence, three types of SSI, MI, venous thromboembolism, urinary tract infection, renal insufficiency, sepsis, pneumonia, septic shock, and acute renal failure. The second composite outcome variable measured the incidence of 30-d mortality, MI, or CVA. The SSI outcome included superficial SSI, deep incision SSI, and organ space SSI that occurred within 30 d of the procedure. Superficial SSI included infections that involved only the skin or subcutaneous tissue of the incision. Deep incision SSI included infection of the deep soft tissue (muscle and fascia) of the incision, whereas organ space SSI included infections of any of the organs or spaces

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