Practice Variations in Anesthesia for Carotid Endarterectomies and Associated Outcomes

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Objective: **The authors' aim was to assess practice variations in anesthesia for carotid endarterectomies (CEA) and report outcomes.**

Design: **A retrospective cohort study.**

Setting: **A multi-institutional setting.**

Participants: **Patients who underwent CEA.**

Interventions: **None.**

Measurements and Main Results: **Using the National Anesthesia Clinical Outcomes Registry of the Anesthesia Quality Institute, CEAs performed from 2010 to 2014 were identified, and a logistic regression model was fitted to determine if various patient, intraoperative, and provider characteristics were associated with usage of regional anesthesia (RA) versus general anesthesia (GA) (primary outcome) as the primary anesthetic in CEAs. The majority of CEAs were performed under GA (31,003 GA v 1,968 RA). American Society of Anesthesiologists class III-V patients were more likely to receive RA than class I-II (odds ratio 1.63, 95% confidence interval 1.39-1.91). Also, board certification status was associated with utilization of RA (odds ratio 2.95, 95% confidence interval 2.59-3.36). Among various facility types, community hospitals had the highest rates of RA use for CEAs. Secondary outcomes studied included extended recovery room stay, unexpected intensive care admissions, inadequate pain control, and postoperative nausea/vomiting. The usage of RA over GA was associated only with decreased postoperative nausea/vomiting.**

Conclusions: **This study was the first to use the National Anesthesia Clinical Outcomes Registry to evaluate practice trends in the utilization of RA versus GA in CEAs. Patient comorbidities, as well as type of anesthesia provider, were associated with the usage of RA.**

KEY WORDS: carotid endarterectomy, general anesthesia, regional anesthesia, outcomes, complications

CAROTID ENDARTERECTOMY (CEA) is a commonly performed procedure used to decrease stroke risk in patients with both symptomatic and asymptomatic carotid disease.[1,2] Current evidence-based guidelines released by the Society for Vascular Surgery state that CEA is beneficial for symptomatic patients with 50% to 99% internal carotid artery occlusion, as well as asymptomatic patients with 60% to 99% internal carotid artery occlusion.[3] Although CEA is a relatively safe procedure, it is associated with risks including cardiovascular instability (hypotension, hypertension, arrhythmias, myocardial infarctions), neurologic deficits, and hypoperfusion syndrome.[4]

Both general anesthesia (GA) and regional anesthesia (RA) techniques can be used to perform CEA. The regional techniques employed usually include both superficial and deep cervical block as well as cervical epidural anesthesia, a less commonly used method. The use of regional anesthesia to perform CEA has been shown to be associated with shorter operative and anesthetic times as well as increased frequency of next-day discharges and, therefore, overall decreased cost.[5–7] Although the overall healthcare cost may be decreased, currently there is no evidence to suggest which technique is superior. Consequently, both anesthetic modalities currently are in practice. Multiple studies have examined differences in outcomes comparing the 2 techniques, with a focus on perioperative myocardial infarction and stroke risk. Currently, there is no conclusive, consistent evidence that there is a statistically significant difference in outcomes when evaluating perioperative myocardial infarction, stroke, and risk of death.[5,6,8,9] The decision to use GA or RA appears to depend on surgeon and anesthesiologist preference and institutional guidelines.

The primary objective of this study was to evaluate the variations in practice when comparing GA and RA in CEAs across the United States. The goal was to elucidate the variations of practice nationwide and determine if perioperative and postoperative outcomes change based on the technique that was employed. To accomplish this, the National Anesthesia Clinical Outcomes Registry (NACOR) of the Anesthesia Quality Institute (AQI) was used and data on CEAs performed from 2010 to 2014 were compiled. NACOR is the largest anesthesia database in the country and stores more than 20% of all anesthetics performed annually.[10] The data come from a combination of billing records and anesthesia information management systems and are transmitted and stored electronically at the AQI headquarters in Schaumburg, Illinois. The AQI has been collecting data since 2010 and compiles information on all aspects of patients undergoing anesthesia for various procedures in all settings.[10] The hypothesis of the study was that there is substantial variability in anesthetic techniques used for CEA procedures, and this variability is affected by multiple factors, including patient demographics, facility type, region, and provider characteristics.

MATERIALS AND METHODS

Data Source

NACOR is a voluntary submission registry with institutions that participate in the sharing of anesthesia-related data and outcomes to evaluate the quality of care both nationally and

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locally.[11] NACOR accepts case-level administrative, clinical, and quality capture data from voluntary participating anesthesia practices and healthcare facilities in the United States. Electronic data are obtained from these institutions, typically on a monthly basis, and data elements are mapped to fields in the NACOR schema in accordance with a publicly available data dictionary. Incoming data are loaded into NACOR by AQI technologists and are subject to both manual and automated review to systematically identify missing elements, miscoding, and inadvertent corruption. Data were collected by AQI from January 2010 to December 2014.[12] The data were accessed on January 28, 2015. The AQI database de-indentifies patient information and contains various data regarding patient demographics, billing, procedural, diagnostic, and provider information as well as rates of adverse events. Because the database is de-identified, it meets the criteria of the Health Insurance Portability and Accountability Act to protect personal information and was exempt from the consent requirement by the authors' institutional review board.

Study Sample

All CEAs between 2010 and 2014 were identified by determining billing data containing the current procedural terminology code 35301. NACOR database provides data indicating the type of primary anesthetic for each case. GA is always considered primary even if RA was used. Therefore, RA was considered primary if it was the sole anesthetic. Patients with American Society of Anesthesiologists physical status (ASA PS) class of 6 and age $<$1-year-old were removed from the study. Furthermore, all cases with missing data for ASA PS class, age, sex, and case duration were excluded. Finally, only cases that reported either GA or RA as primary anesthetic were included. Figure 1 illustrates the exclusion methodology.

The primary objective of this study was to evaluate the variations in practice when comparing GA with RA in CEAs across the United States. Secondary outcomes of this study included extended recovery room stay, inadequate pain control, unexpected intensive care unit admission, and postoperative nausea/vomiting (PONV). Patient, intraoperative, provider, and facility characteristics were compared for CEAs performed under GA versus RA as the primary anesthetic type. Patient characteristics included age, sex, and ASA PS. ASA PS classes I and II are combined because some billing systems in NACOR report it this way, and it, therefore, would not have been possible to separate the two classes in this particular study. Of note, it was reasonable to think there were very few ASA PS class I patients in this particular patient population given the nature of the surgery.

Anesthesia provider information included presence of anesthesiology resident, certified registered nurse anesthetist (CRNA), and board-certified anesthesiologist (v non board-certified). Resident data referred specifically to anesthesiology residents and does not include surgical resident data. Intraoperative data included case duration, mean duration in minutes, and case duration categories ($\leq$180 min or $>$180 min). Healthcare-system-related characteristics included facility type: university hospitals, large community hospitals ($>$500 beds), medium community hospitals (100-500 beds), small community hospitals ($<$100 beds), specialty hospitals, and freestanding surgery centers. NACOR also contains data for other facility types, such as attached surgery centers, pain clinics, and surgeon's offices, and were grouped as "other." Furthermore, data on United States region were collected (Northeast, Midwest, South, and West). Data regarding symptomatology of carotid stenosis were collected by identifying ICD9 coding for each case. Presence of ICD9 code of 433.10 classified patients has having carotid stenosis without cerebral infarct, whereas 433.11 classified patients as having carotid stenosis with cerebral infarct.

Likewise, anesthesia-related outcomes also were compared for GA versus RA. Outcomes chosen were extended post-anesthesia care unit (PACU) stay, inadequate pain control, PONV, and unexpected intensive care unit (ICU) admissions.

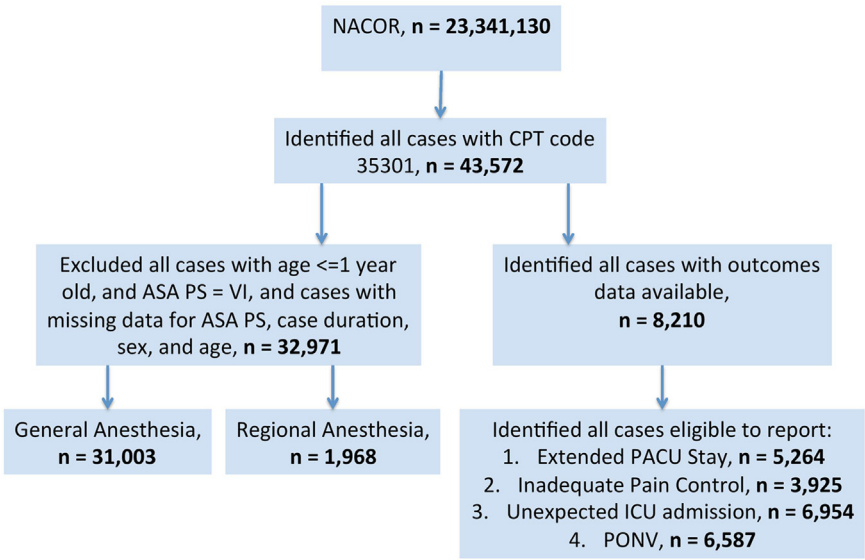

Fig 1. Illustration outlining exclusion methodology for the current analysis. NACOR, National Anesthesia Clinical Outcomes Registry; CPT, current procedural terminology; ASA, American Society of Anesthesiologists.