Economic Evaluation of Carotid Artery Stenting Versus Carotid Endarterectomy for the Treatment of Carotid Artery Stenosis

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BACKGROUND: The clinical effectiveness of carotid endarterectomy (CEA) is well established. But the economic impact of CEA and carotid artery stenting (CAS) is still uncertain. The objective of this study was to compare hospital costs and reimbursement for CAS and CEA.

STUDY DESIGN: We performed a retrospective database analysis on pair-matched patients who underwent CEA (n = 31) and CAS (n = 31) at the Richard M Ross Heart Hospital in Columbus, OH. The hospital's clinical and financial databases were used to obtain patient-specific information and procedural charges. Cost data were generated by applying the hospital's ratio of cost to charges for all DRG charges. The Wilcoxon signed-rank test was used to examine the differences between costs of these procedures.

RESULTS: Data are reported as mean ± SD. The mean age of patients in CAS group was 70.14 years (± 1.60 years) versus 68.64 years (± 1.75 years) for CEA patients ($p < 0.05$). The total direct cost associated with CEA ($3,765.12 ± $2,170.82) was significantly lower than the CAS cost ($8,219.71 ± $2,958.55, $p < 0.001$). The mean procedural cost for CAS ($7,543.61 ± $2,886.54) was significantly higher than that for CEA ($2,720.00 ± $926.38, $p < 0.001$). The hospital experienced cost savings of $9,690.87 for CEA versus $4,804.79 for CAS from private insurance. Similarly, savings obtained by Medicare-enrolled CEA patients were higher than those for CAS patients ($1,497.79).

CONCLUSIONS: CAS is significantly more expensive than CEA, with a major portion of cost attributed to the total procedural cost. The hospital experienced significant savings from CEA procedures compared with CAS under all DRG classifications and insurers. Hospitals must develop new financial strategies and improve the efficiency of infrastructure to make CAS financially viable. (J Am Coll Surg 2007;205:413–419. © 2007 by the American College of Surgeons)

Atherosclerotic carotid artery stenosis has the potential to cause major neurologic complications such as a transient ischemic attack or an ischemic stroke. Ischemic stroke is the third leading cause of death in the US, with an estimated total cost of $50 billion annually.[1-3] Carotid endarterectomy (CEA) has been established as the standard therapy for high-grade stenosis of the extracranial carotid arteries.[4,5] But in recent years, carotid angioplasty and stenting (CAS) has emerged as an innovative and less invasive approach for treating carotid artery stenosis in high-risk patients. Although the merits and longterm clinical benefits of CAS compared with CEA are being clarified, the economic impact is no less important. A few studies have reached contradictory conclusions about the cost effectiveness of CAS.[6,7] The objective of this study was to analyze reimbursement and perform a cost comparison, specifically, of procedural and nonprocedural costs of CAS versus CEA for the treatment of carotid artery stenosis.

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METHODS

Study design and population

This was a retrospective study comprised of patients with a diagnosis of atherosclerotic carotid artery stenosis

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Abbreviations and Acronyms
CAS = carotid artery stenting
CEA = carotid endarterectomy
RCC = ratio of cost to charges

admitted to the Richard M Ross Heart Hospital (Ohio State University Medical Center) in Columbus, OH, between March 1, 2004, and March 31, 2006. Subjects were identified using ICD-9 (International Classification of Diseases, 9th revision) codes for carotid artery stenosis (433.10 to 433.30).[8] Patients were treated with either CEA or CAS based on the judgment of the vascular surgeon and the credentialing criteria of our institution. CEA was performed by five board certified vascular surgeons in the Division of Vascular Surgery at Ohio State University. CAS was performed by one vascular surgeon (JES) at the Richard M Ross Heart Hospital. The Centers for Medicare and Medicaid Services recently approved the use of CAS for stenosis greater than 70%, for those who have already had a stroke or demonstrated other clear symptoms of carotid disease, or those whose risk for surgery is clearly increased (< 10% of patients undergoing CEA).[9] Approval for the study was obtained from the Institutional Review Board of Ohio State University Medical Center.

Patient characteristics

The medical center's clinical and financial databases were used to retrieve patient-specific information, including demographics, insurance carrier, Diagnosis Related Group (DRG) classification, comorbidities, type of discharge, and total hospital length of stay associated with both procedures (Table 1).

Patients who underwent CAS procedures were pair-matched with those treated with CEA. Pair-matching was deemed appropriate because of the small number of patients in the CAS group. It was also considered a useful strategy to control for potential confounders. Subjects were pair-matched using six confounding variables, including age, gender, race, DRG classification, length of stay, comorbidities (measured by the Charlson index), and preoperative and postoperative complications such as congestive heart failure and stroke. The Charlson index was developed to predict the risk of mortality from comorbid illness within a 1-year period. Severity weights were developed (based on estimation of relative risks of death) for 19 comorbid conditions.

Table 1. Demographics of Patients Treated with Carotid Endarterectomy (n = 31) and Carotid Stenting (n = 31)

Variable	Carotid endarterectomy	Carotid stenting
Age, y		
Mean (SD)	67.77 (1.84)	69.10 (1.60)
Range*	41–86	50–89
Gender, n (%)		
Male	20 (64.52)	20 (64.52)
Female	11 (35.48)	11 (35.48)
Race, n (%)		
Caucasian	28 (90.32)	28 (90.32)
African American	3 (9.68)	3 (9.68)
Charlson comorbidity index, mean (SD)	1.87 (1.39)	1.67 (1.38)
DRG classification, n (%)		
DRG 533	18 (58.06)	16 (51.72)
DRG 534	13 (41.94)	15 (48.28)
Type of discharge, n (%)		
Routine discharge to home	29 (93.55)	26 (83.87)
Discharge to home care or skilled nursing facility	2 (6.45)	5 (16.13)
Length of hospitalization, d		
Mean	1.4 (1.54)	1.3 (2.46)
Range	1–9	0–8

*Level of significance: $p < 0.05$.

Patients were classified by the hospital's professional coding staff into several DRGs under which the hospital was reimbursed. DRGs used for both CEA and CAS procedures were DRG 533 (extracranial procedures, patients with significant comorbidity or complication) and DRG 534 (extracranial procedures, patients without significant comorbidity or complication). Reimbursement data from Medicare and the top (by volume) four other insurance companies were obtained from the hospital's finance department.

Cost data

The total direct costs for each procedure were further categorized into procedural and nonprocedural costs. Procedural costs included costs for operating room or catheterization laboratory; room and board during postprocedural care, including ICU; and central supplies. Operating room costs and catheterization laboratory costs reflected resources and time needed to perform the procedure in the operating room or catheterization laboratory, including room services, anesthesia, and blood storage and processing. Room and board costs included resources and services provided to patients during the hospital stay. Postprocedural care involved costs for step-