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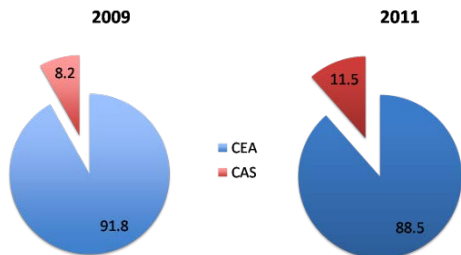
INTRODUCTION

Carotid Revascularization Endarterectomy Versus Stenting Trial (CREST) results, published in 2010, showed no difference in outcome between carotid artery stenting (CAS) and carotid endarterectomy (CEA). We aim to determine whether there has been any change in utilization or outcomes of CAS and CEA after CREST results.

METHODS

We determined the frequency of CAS and CEA procedures performed in the state of Minnesota, in the years 2009 (pre-CREST period) and 2011 (post-CREST period), using data from the Minnesota Hospital Association. Pre- and post-CREST CAS and post-CREST CEA rates and outcomes were compared with pre-CREST CEA (reference). In-hospital outcomes were analyzed after adjusting for potential confounders using multivariate analysis.

Figure 1: Rate of CEA and CAS in 2009 and 2011



RESULTS

Table 1: Patients' demographic and clinical characteristics, hospital characteristics, and discharge outcomes

	CEA 2009(Ref)	CAS2009	p-value	CEA 2011	p-value	CAS 2011	p-value
Overall Number (%)	n=1308	n=113		n=1143		n=141	
Age mean (CI)	71(70-71)	69(67-72)	0.0007	71(70-71)	0.4	70(68-72)	0.2
Women	584(44.6)	50(44.2)	0.9	455(39.8)	0.01	60(42.5)	0.6
Co-morbid conditions							
Hypertension	875(66.9)	74(65.4)	0.7	777(67.9)	0.5	97(68.7)	0.7
Diabetes mellitus	49(3.7)	9(7.9)	0.04	65(5.6)	0.02	8(5.6)	0.2
Dyslipidemia	143(10.9)	5(4.4)	0.02	110(9.6)	0.3	13(9.2)	0.6
Atrial Fibrillation	115(8.7)	15(13.2)	0.12	131(11.4)	0.03	18(12.7)	0.1
Congestive heart failure	92(7.0)	16(14.1)	0.01	71(6.2)	0.4	10(7.0)	0.9
Coronary Artery Disease	491(37.5)	48(42.4)	0.3	426(37.2)	0.9	55(39.0)	0.7
Chronic lung disease	15(1.1)	1(0.8)	0.8	10(0.8)	0.5	0(0.0)	0.3
Smoking	253(19.3)	22(19.4)	0.9	235(20.5)	0.4	24(17.0)	0.5
Asymptomatic Patient	1212(92.6)	86(76.1)	<0.0001	1050(91.8)	0.4	114(80.8)	<0.0001
In hospital complications							
Pneumonia	13(0.9)	3(2.6)	0.1	6(0.5)	0.2	1(0.7)	0.7
Deep venous thrombosis	1(0.0)	1(0.8)	0.1	1(0.0)	0.9	0(0.0)	0.7
UTI	30(2.2)	7(6.1)	0.02	26(2.2)	0.9	9(6.3)	0.01
Sepsis	0(0.0)	2(1.7)	0.006	1(0.0)	0.4	0(0)	
Pulmonary Embolism	0(0.0)	1(0.8)	0.07	2(0.1)	0.2	0(0)	
Length of stay Mean (CI)	2.4(2.2-2.6)	4.4(3.4-5.3)	<0.0001	2.2(2.4-2.5)	<0.0001	3.1(2.4-3.8)	<0.0001
Hospital charges Mean (CI)	32079(30382-33776)	67258(55363-79154)	<0.0001	36521(34628-38414)	0.1	57447(51045-63848)	<0.0001

Table 2: Multivariate Analysis

Outcomes	CAS 2009 VS CEA 2009		CEA 2011 VS CEA 2009		CAS 2011 VS CEA 2009	
	Adjusted for age, gender, and risk factors †	P value	Adjusted for age, gender, and risk factors †	P value	Adjusted for age, gender, and risk factors †	P value
Home/Self care	OR (95% C.I.) 0.3(0.2-0.6)	0.0004	OR (95% C.I.) 0.7(0.5-1.0)	0.04	OR (95% C.I.) 0.3(0.2-0.5)	<.0001
Neurological Complication	3.5(1.1-10.4)	0.02	1.0(0.4-2.2)	0.9	1.4(0.3-6.4)	0.6
Cardiac Complication	5.2(1.9-14.4)	0.001	1.0(0.4-2.0)	0.9		
Composite	4.0(1.8-8.6)	0.0002	1.0(0.5-1.6)	0.8	0.9(0.3-2.8)	0.9
In hospital mortality	2.4(0.4-11.8)	0.2	0.7(0.2-2.7)	0.6	2.8(0.5-15.8)	0.2

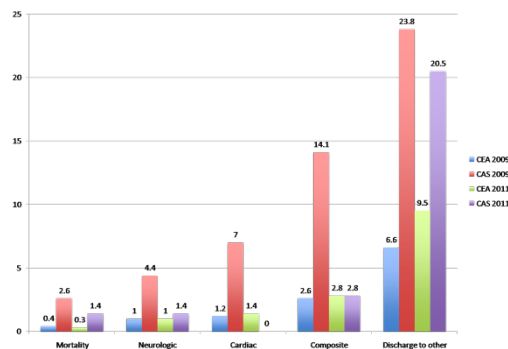


Figure 2: Comparison of Outcomes

RESULTS

A total of 2,718 patients underwent CEA or CAS in pre- and post-CREST period. The frequency of CAS increased from 8.2% to 11.5% of the total patients treated (p=0.004). In the pre-CREST period, CAS group (compared with CEA) were younger, had higher rate of diabetes mellitus and congestive heart failure, in-hospital occurrence of urinary tract infection, sepsis, and myocardial infarction. In the post-CREST period, CAS group did not differ from CEA group in demographics, medical co morbidities, or in-hospital complications except UTI. Hospital stay and hospital charges were greater with CAS compared to CEA, however, the differences in 2011 were less than in 2009.

After adjusting for age, sex, relevant risk factors and hospital complications, compared with pre-CREST CEA, pre-CREST CAS was associated with higher neurological complications (odds ratio [OR] 3.3; 95% confidence interval [CI] 1.1-10; p=0.03), cardiovascular complications (OR 5.0; 95% CI 1.8-14; p=0.001), and composite outcome of neurological complications, cardiovascular complications, or death (OR 4.0; 95% CI 1.8-8.6; p=0.0007). There was no difference in outcomes or procedure-related complications between post-CREST CAS and either pre- or post-CREST CEA.

CONCLUSION

There has been a significant increase in the number and improvement in outcome of CAS procedures performed after publication of CREST results in state of Minnesota, presumably due to higher rates of CAS performance in average surgical risk patients.