The Carotid Endarterectomy (CEA) in Quebec:
A Study of the Last Three Years

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November, 2002

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfilment of a Masters of Science in Experimental Surgery

Your file Votre référence
ISBN: 0-612-88221-7
Our file Notre référence
ISBN: 0-612-88221-7

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Abstract

Introduction: The Carotid Endarterectomy (CEA) is used for stroke prophylaxis in asymptomatic carotid stenosis and in patients with previous strokes or transient ischemic attacks

Objective: To audit the operative results of the CEA in the province of Quebec between 1996 and 1999.

Methods: The Quebec Medical Discharge Summary Database provided demographics and surgical complications following all CEAs performed between 1996-1999.

Results: The CEA was performed at a rate of 42 procedures/100 000 persons aged greater than 40 however this rate appears to be declining over the study span. Being operated on by a neurosurgeon was an independent risk factor for peri-operative stroke (OR 1.55, 95%CI 1.12-2.12). There was no difference in outcomes between teaching and non-teaching centres.

Conclusion: The CEA is being used less frequently recently and is being performed fewer times than in the United states. Neurosurgeons have poorer outcomes which might be due to surgeon factors or poorly controlled counfounders.

Résumé

Introduction: L'endartériectomie carotidienne (EC) a été démontré efficace dans la prévention des accidents cérébraux vasculaires (AVC) pour les patients ayant une sténose carotidienne asymptomatique et symtomatique (ancien AVC ou ischémie cérébrale transitoire).

Objective: Évaluer les résultats opératoires de l'EC dans la province de Québec entre 1996 et 1999.

Méthodes: Tous les cas d'EC fait entre 1996 et 1999 ont été obtenus à partir de la banque de données québécoises des résumés sommaires. Cette banque contient de plus l'ensemble des complications chirurgicales.

Results: Le taux d'EC était de 42 procédures/100 000 personnes âgées de plus de 40 années et ce taux a décliné au cours de la période étudiée. Être opéré par un neurochirurgien semble être un facteur de risque indépendant d'AVC péri-opératoire (OR 1.55, 95%CI 1.12-2.12). Il n'y a pas de différence statistiquement significative entre les centres universitaires et non-universitaires.

Conclusion: Au cours de la période étudiée, le taux d'EC a diminué et est moindre qu'aux États-Unis. Les neurochirurgiens ont de moins bons résultats chirurgicaux ce qui peut à la fois dépendre de facteurs reliés aux chirurgiens ou à des facteurs de risque mal contrôlés dans cette étude.

Acknowledgments:

Thank you to Lysette Trahan from the Ministry of Health and Social Services for providing the Med-Echo Database

Thanks to Patrice Nault for editorial assistance

Thanks to John Sampalis for editorial assistance

Thanks to Louise Pilote for editorial assistance

All data analysis was performed using SPSS®

I would like to thank my wonderful wife Najia and her very loving family, the Mahmoods. I am also indebted to my parents for their love and support.

Contribution of Authors:

Kashif Irshad performed all data analysis and was the primary author for the thesis and for the manuscripts. French translation was performed by Patrice Nault from the Centre Hospitalier de la Vallee D'Outaouais, Hull. None of the manuscripts have been published by the date of thesis submission.

The Carotid Endarterectomy (CEA) in Quebec:
A Study of the Last Three Years

Background

The first CEA was reported in the Lancet in 1954 by Eastcott, who successfully reconstructed the carotid artery of a 66-year old female suffering from transient ischemic attacks (TIA's).[1] The reconstruction involved removal of a plaque causing stenosis of the carotid artery that was confirmed by angiogram. Since then, there has been a considerable evolution in surgical technique and accepted indications for the CEA. Surgery involves performing an arteriotomy, and removing an atheromatous plaque, the main sources of emboli that are the culprit for TIA's and cerebral infarcts. Eras of enthusiasm have been followed by those of skeptecism because of constant disagreements about surgical indications for carotid stenosis. These discussions have been fuelled by the publication of many large- multi-centered- randomized controlled trials (RCT). Rates of CEA rose until the mid-80s when numerous studies demonstrated an unacceptably high complication rate.[2,3,4] The reportedly high stroke rate raised questions regarding the benefit of CEAs for stroke prevention.

However, results from the RCT began to be disseminated in 1991 resulting in a dramatic increase in the use of the CEA for the prevention of stroke. The initial studies focussed on symptomatic patients with carotid stenosis. Symptomatic patients were those who had TIAs or previous strokes. Ensuing studies examined the preventive benefit of CEA in asymptomatic stenosis detected radiologically.

The first study was the North American Symptomatic Carotid Endarterectomy Trial (NASCET). Fifty centres in Canada and the United States randomised 659 patients with symptomatic carotid stenosis (stenosis between 70 and 90%) to medical (n=331) and surgical (n=328) treatment.[5]

The study was prematurely halted due to early results demonstrating a significant benefit to endarterectomy. For the randomised patients, the 2-year cumulative risk of ipsilateral stroke was 26% in the medical group and only 9% in the surgical group, with an absolute risk reduction of 17%. The NASCET group demonstrated that there was a less robust benefit from endarterectomy in those with moderate stenosis (50-69%) and no therapeutic benefit in symptomatic patients with stenosis less than 50%. This trial convinced most physicians about the benefit of endarterectomy. Ensuing studies confirmed the benefit of CEA in symptomatic patients with moderate to severe stenosis.[6,7]

However, operating on patients who have had a recent stroke entails a significantly higher risk of severe peri-operative complications. In 1964, Wylie et al was the first to report the high incidence of post-operative cerebral hemmorhage following CEA in 9 symptomatic patients[8]. Five of his patients suffered a hemorrhagic stroke between 2 hours and 3 days following surgery. Larger studies that followed confirmed the high risk. The Joint Study of Extracranial Arterial Occlusion, published in 1969, demonstrated a 42% mortality amongst fifty patients who were treated with CEA less than two weeks after an embolic stroke[9]. Therefore, most surgeons prefer to wait a minimum of 5 weeks following the acute event before performing the CEA. This time was validated by Giordano et al in 1985. Post-operative stroke rate was 18.5% in the 27 patients who CEA within 5 weeks and 0% in the 22 patients who received surgery after 5 weeks[10].

Patients with TIA or a "stroke in progress" are managed more aggressively. TIA's are associated with a very high risk for ensuing stroke and therefore may benefit for quick removal of a carotid lesion if identified eventhough data supporting this is scarce. Mentzer et al reported a series of 12 patients with TIAs and high-grade carotid stenosis. Of the five patients managed non-operatively, 4 sufferred strokes. The rest of the patients were treated with CEA and all seven of them had a complete recovery.[11] A emergent CEA may limit the ischemic damage in patients suffering from a "stroke in progress". In a series of 206 patients with an evolving stroke, 69% suffered hemiparesis, 5% monoparesis, and 14% died while only 12% recovered.[12] Studies evaluating surgical management showed a significant advantage. Greenhalgh et al reported that of the 15 patients operated on for a "stroke in progress" 6 recoverred fully, 8 had significant neurological improvement, while one had a completed stroke.[13]

CEA in asymptomatic patients with carotid stenosis remains the most controversial indication for the procedure. The stenosis is frequently detected following the discovery of a carotid bruit, as a result of a screening ultrasound prior to major surgery, or from evaluation of a contralateral symptomatic carotid lesion[14]. Several randomized controlled trials have evaluated CEA in asymptomatic patients, comparing them to best medical therapy.

The Asymptomatic Carotid Atherosclerosis Study (ACAS) randomized 1662 patients with asymptomatic carotid stenosis of 60% or greater. Patients randomised to medical therapy received daily asprin and risk factor modification. With a median follow-up of 2.7 years, with 4657 person-years of observation the aggregate 5-year risk of ipsilateral stroke and any peri-operative stroke or death was estimated to be 5.1% for surgical patients and 11% for patients treated medically, with a 57% risk reduction for those treated with endarterectomy[15]. The advantage was only shown among men, who had a risk reduction of 66% when compared to women who had a risk reduction of only 17%. Few patients in the study underwent pre-operative angiogram which in itself carried a stroke risk of 1.2% in the study. This high rate questions the use of angiogram in asymptomatic stenosis. They concluded that CEA should be performed in all asymptomatic patients with greater than 60% stenosis and whose general health makes them good candidates for elective surgery if the CEA can be performed with less than 3% perioperative morbidity and mortality.

However these conclusions have been aggressively scrutinized following publication. A consensus statement published by the Canadian Stroke Consortium highlighted the irreproducibility of the ACAS results because of the restricted elegibility criteria (25 patients screened for each patient enrolled), and the strict selection of surgeons[16]. The selection of relatively healthy patients and skilful surgeons resulting in a very low surgical complication rate which may be unachievable in the surgical community at large. ACAS-surgeons had to have performed a minimum of 12 CEAs per year and an audit of their last 50 CEAs demonstrating a combined neurological morbidity and mortality rate of <3.0% for asymptomatic patients and <5% for symptomatic patients. They justify this by concluding that a method for selecting surgeons to perform CEA was successful in providing a low complication rate and therefore substantiates the use of CEA in asymptomatic patients[17].

Barnett et al were critical of the ACAS trial because they concluded that (1) the analysis was statistically flawed[18](2) the follow-up time was inadequate and therefore the statements regarding 5-year stroke rate are unsubstantiated (3) the emphasis given to the risk reduction of 57% , particularly when the initial risk was relatively small, has led to overly optimistic conclusions because "doubling a trivial risk is still trivial". [19]

The Veterans Affair Cooperative Asymptomatic trial randomized 444 asymptomatic men with carotid stenosis greater than 50% and followed them for a mena of 47.9 months. They demonstrated a significant benefit of surgery with any ipsilateral neurological event as the endpoint (Surgical 8.0% vs medical of 20.6%). However, no difference was noted in mortality. The study was criticized for its small sample size and the exclusion of females. [20]

The benefit of CEA has also been questioned because of evidence that many embolic strokes do not originate from the carotid plaque and therefore the risk reduction associated with CEA is overestimated. In a recent study, Inzitari et al found that 45% of strokes in patients with asymptomatic stenosis of 60-99% are attributable to lacunes (small vessel infarcts) or cardioembolism [21]. Lacunar and cardioembolic strokes cannot be prevented by CEA. In symptomatic patients, 80% of strokes originate from the carotid[22,23]. They imply that the outcome that should be studied in assessing benefit of CEA should have been reduced to large artery infarcts only. They therefore question the validity of the ACAS study, however also suggest that there may be a subgroup of asymptomatic patients who will derive a clinically meaningful benefit from endarterectomy. Two major studies are underway to add to our knowledge regarding the benefit of CEA in asymptomatic patients, and perhaps the intense criticism of the ACAS trial may guide the investigators to produce a more inclusive study with a more specific outcome. [24,25]

Based on published data the American Heart Association developed a consensus statement about the use of carotid endartectomy[26]. They conclude that the combined stroke and death rate much exceeding 3% for asymptomatic patients and 6% for symptomatic patients would eliminate the benefit in stroke reduction obtained through the operation.

Throughout the literature, reported complication rates vary significantly. A systematic review of 51 studies on symptomatic patients found that the risk of peri-operative stroke varied with the methods and authorship of the report[27]. If the patients were assessed by neurologists the stroke rate was 7.7% , however if there was only one surgeon assessing his own results, the stroke rate was 2.3%. In 1991, the combined mortality and stroke rates were estimated to be between 5 and 11% for all American Medicaire patients[28]. These differences highlight the wide range of rates, likely secondary to reporting bias. Also, mean reported rates are at the upper limits of acceptability, suggesting a borderline advantage of CEA in the prevention of stroke[29].

These studies emphasise the importance of quality control measures in order to maintain an acceptable morbidity and mortality rate. The American Heart Association Stroke Council issued a series of recommendations, stating that " all medical institutions that treat extracranial arterial occlusive disease continually monitor results of surgery through a formal ongoing audit."[30] They also went on to suggest methods to audit surgeons and the need to limit surgical priveledges to those who can document that their results fall within an acceptable range. However, studies have shown than most surgeons are unaware of their results. Only 15% of physicians polled knew the peri-operative stroke rate at the hospital where they perform or refer patients to have CEA[31]. 50% of neurologists and 60% of surgeons knew the stroke rate at their institution. A second study evaluated surgical residency programs[32]. When program directors were questioned, 20% of the programs indicated that they were not monitoring CEA complication rates. Without knowledge of the quality of the surgery at an institution, it is impossible to determine whether the benefits of CEA outweigh the risks.

Kresowick et al designed a quality improvement project where outcomes for 30 hospitals were confidentially provided to the surgeons of the respective hospitals. Surgeons performing the procedure were invited to meetings to discuss care process variation and outcomes. The state-wide combined stroke or mortality rate decreased from 7.8% in 1994 to 4.0% in 1996. Fourteen hospitals continued the study and reduced their mean rate to 1.8%. Therefore, feedback results in improvement in outcomes, likely secondary to improved care and surgical technique. Also, surgeons who question their own abilites to perform the procedure safely may elect to stop performing the CEA knowing that their results will be provided to them. [33]

Objective of Thesis:

The Objective of this thesis is to study the experience of the carotid endartectomy in the province of Quebec, specifically over the last three years. The three areas that we will examine are:

(1) The rate of carotid endartectomies in the province of Quebec, and an analysis of any outcomes between 1996-1999.
(2) An analysis of surgical outcomes between symptomatic and asymptomatic patients
(3) A comparison between the three surgical specialties that most frequently perform CEAs: the general surgeon, the vascular surgeon, and the neurosurgeon
(4) A comparison between teaching and non-teaching hospitals performing carotid endarterectomy.

Materials and Methods

A database of patients undergoing CEA between 1996-1999 was obtained from MED-ECHO. MED-ECHO is an anacronym for Maintenance et Exploitation de Donnees pour L'Etude de la Clientele Hospitaliere. MED-ECHO was conceived in 1976, and adopted by all Quebec hospitals in 1980. It is a computer based information retrieval system run by the Ministere de la Sante et des Services Sociaux of the province of Quebec. It contains information on all hospitalisations in the province of Quebec. For each admission, a discharge form (AH-101-P) is completed by the physician and coded by an archiviste using ICD-9th edition (International Classification of Disease) and the Classification canadienne des actes diagnostics, therapeutic et chrurgicaux (2nd edition). The discharge summary includes many variables, including discharge diagnosis, co-morbid conditions, operative procedure performed, complications, length of stay and primary physician. The codes from each admission are electronically sent from the treating hospital to the MED-ECHO database. Once centralized, the data is filtered for possible errors. Each variable is validated individually by ensuring that an appropriate code is entered. If a code appears to be misplaced the file is returned to the hospital for corrections.

In order to obtain our completed database, the following codes were requested from MED-ECHO for patients hospitalised between 1996-1999.

All patients who had the code 50.12 (Hospitalised patients who underwent a carotid endarterectomy) were included in the database. This does not include patients who underwent concomitant coronary artery bypass surgery. Specific variables were provided for each patient hospitalised for a carotid endarterectomy and these are described in Table 1. ICD-9th edition did not provide anatomic location, degree of stenosis, operating surgeon, or details about the surgical technique. MED-ECHO also provided the number of CEAs (50.12) performed in Quebec from 1991-1999. Quebec population data was provided by Statistics Canada.

Table 1: Codes used to obtain database from MED-ECHO

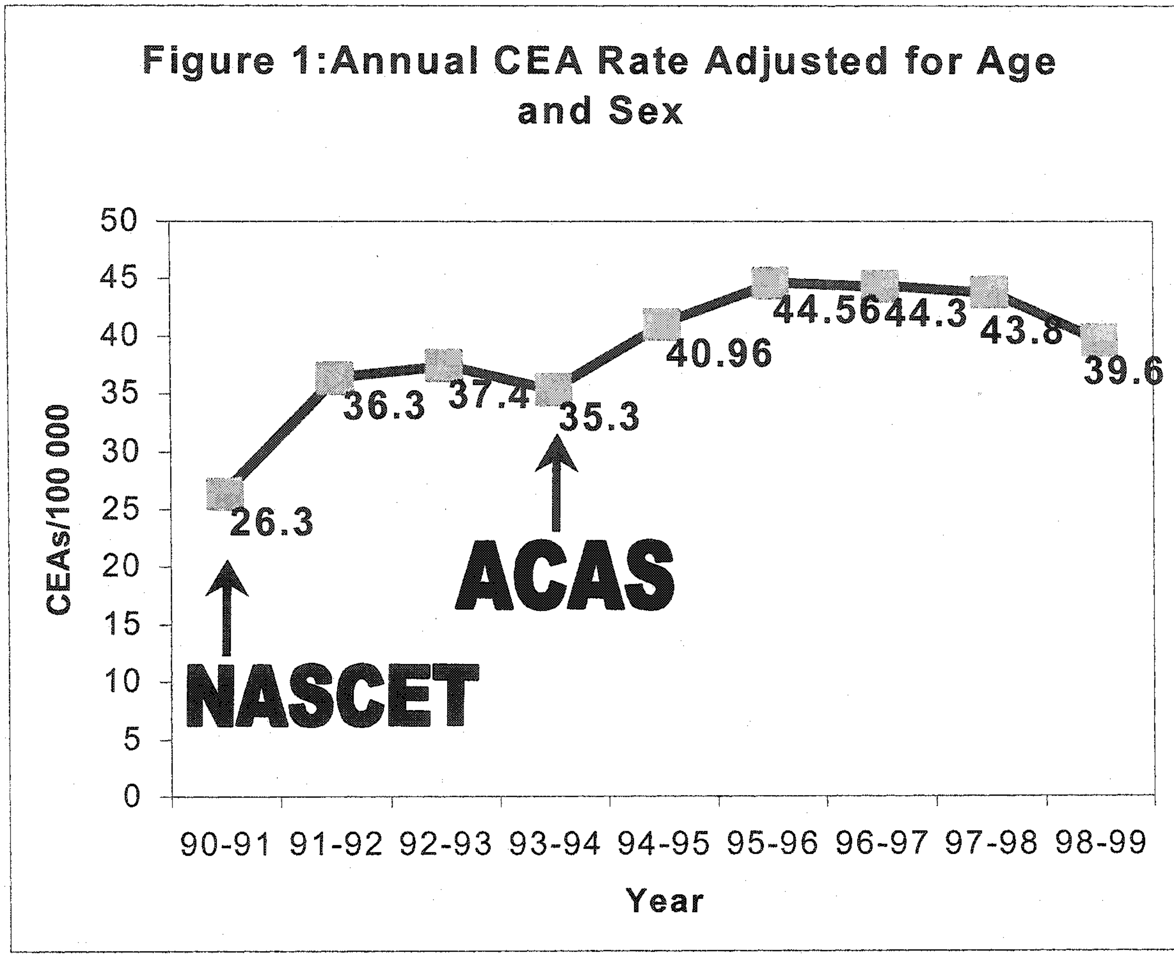
Variable	Code (MED-ECHO or ICD)	Comments on output
Hospital Code	CODETAB	The hospital where each CEA is performed
Age of patient	CODEAGE	The database included all age groups.
Sex of patient	SEXE	H= men F=women
Medicare # of patient	NAM	-
Surgeon specialty	SPEC_CHI	20= Cardio or vascular surgeon 24= General surgeon 30= Neurosurgeon
Length of stay	SEJOUR	# of days between date of admission and discharge
Death during admission	DECES	1= yes 2=no
Anesthetic technique	TECHANES	06=general anesthesia 01= local anesthesia
Admitted with Stroke as principal or secondary diagnosis(previous stroke)	436	1=yes 2=no Yes= symptomatic patient
Admited with Transient cerebral ischemia as principal or secondary diagnosis (previous TIA)	435	1=yes 2=no Yes= symptomatic patients
Admitted with transient paralysis of limbs as principal or secondary diagnosis (previous TIA)	781.4	1=yes 2=no Yes=symptomatic patient
Admitted with Amarosis Fugax as principal or	362.3	1=yes 2=no Yes= symptomatic

secondary diagnosis		patients
Admitted with subjective visual disturabances as principale or secondary diagnosis	368.1	1=yes 2=no Yes=Likely to be a TIA and therefore symptomatic patient
CAD as secondary diagnosis	414.0	1=yes 2=no Yes= risk factor
Hypertension as secondary diagnosis	401.9	1=yes 2=no Yes= risk factor
COPD as secondary diagnosis	496.9	1=yes 2=no Yes= risk factor
Renal failure (acute or chronic) as secondary diagnosis	584, 585, 586	1= yes 2= no Yes= risk factor
Diabetes as secondary diagnosis	250.0	1=yes 2=no Yes=risk factor
Non-dependant use of tobacco	305.1	1=yes 2=no Yes= risk factor
Stroke as complication from surgery	436x	1=yes 2=no
Central nervous complication from surgery	997.0	1=yes 2=no
Cardiac complication from surgery	997.1	1=yes 2=no
Any other complication from surgery (non-cardiac, non-CNS complication)	998,999	1=yes 2=no
Complication requiring re-operation	50.12x	1=yes 2=no

Results

(1) The Rate and Outcomes of CEAs Performed in Quebec

The MED-ECHO database contained 4193 cases of CEAs preformed between 1996 and 1999 (a three year span) at 39 institution in the province of Quebec. Between 1991 and 1999 there were 10870 CEA performed in Quebec. Using the population demographic data from Statistics Canada, and using direct standardisation to control for changes in age and sex the number of CEAs per 100 000 patients greater than 40 years of age were calculated from 1991-1999 (Figure 1). Between 1991-and 1997, there was an increase in the rate of CEAs performed. The sudden jump in the rate in 1991 corresponds with the publication of the NASCET trial. The second jump corresponds with the publication of the ACAS trial. However, there was a 10.7% reduction in the rate from 1996 to 1999.



Analysis of the decline in rate

Patient age, sex, and comorbid distribution between 1996 and 1999 are shown in Table 2.

Table 2: Age and sex

Characteristic	1996-1997	1997-1998	1998-1999	Overall	%change	P
Age ±2SD	67.5±17.2	68.0±17.0	67.6±17.2	67.7±17.1	+0.1%	NS
Male %	63.4%	66.3%	66.2%	65.3%	+4.4%	0.1
Symptomatic %	19.5%	19.3%	19.2%	19.3%	-1.5%	NS
CAD%	14.4%	18.8%	18.9%	17.2%	+31%	0.003
HTN%	35.4%	40.6%	45.0%	40.2%	+27%	<0.001
COPD%	5.4%	7.2%	7.8%	6.8%	+44%	0.025
Diabetes%	15.2%	16.6%	17.4%	16.3%	+14.4%	NS
Renal Failure%	3.8%	3.1%	3.5%	3.5%	-7.9%	NS
Smoker%	4.9%	5.2%	6.8%	5.6%	+18.0%	0.055

There were no significant differences in age, sex, or proportion of symptomatic patients over the years. Even though the ratio of males increased between 1996 and 1998, it was not statistically significant (χ^2-test: p=0.1). There was significant increase in the proportion of patients with coronary artery disease, hypertension, and chronic pulmonary obstructive disease (χ^2-tests) . All patients who had a history of a cerobrovascular accident or a transient ischemic attack were considered symptomatic patients.

The change in CEA rates during the decline among different cohorts are displayed in Table 3. All hospitals that maintained an affiliation with a university were granted university status, while others were designated as community hospitals. There was a 10.6% reduction in the rate of CEA performed between 1996 and 1998. Neurosurgeons increased their proportion of CEA performed over the 3-year span by almost 50% while the proportion performed by vascular surgeons was reduced by 15.6%. Teaching hospitals contributed less, while non-teaching hospitals increased their contribution between 1996 and 1998.

Table 3: Breakdown of the decline in rate between different groups

Group	1996-1997 CEA/100 000 (%)	1997-1998 CEA/100 000 (%)	1998-1999 CEA/100 000 (%)	Change CEA/100 000 (%)	P Chi^2
Overall	44.3 (100)	43.8 (100)	39.6 (100)	4.7	
Vascular	22.7 (51.2)	20.3 (46.3)	17.1 (43.2)	-5.6 (-15.6)	<0.001
General	13.6 (30.7)	13.5 (30.8)	12.3 (31.1)	-1.3 (-1.3)	NS
Neurosurgery	7.4 (16.7)	9.4(21.5)	9.9 (25)	+2.5 (+49.7)	<0.001
Non-teaching	11.9(26.9)	15.1(34.5)	13.3(33.6)	+1.4 (+25)	<0.001
Teaching	32.4(73.1)	28.7(65.5)	26.3(66.4)	-6.1(-9.2)	<0.001

Outcomes of CEA during the three years are displayed in Table 4. Despite a reduction in stroke rate there was an increase in the rate of myocardial infarction. This increase in the rate of MI correlated well with the 41% increase in the death rate (R=0.163, P<0.001, Pearson correlation). There was a significant improvement in the length of stay between 1996 and 1999.

Table 4 Outcomes over the last three years

Outcome	1996-1997	1997-1998	1998-1999	%Change	P
Stroke rate(%)	5.64	6.1%	4.7%	-16.7%	NS
MI rate (%)	1.4%	2.2%	2.1%	+50%	NS
Death rate (%)	0.78%	1.0%	1.1%	+41%	NS
Length of stay (Days)	7.69	7.32	6.28	-18.3%	<0.001 ANOVA

(2) Comparison of symptomatic patients and asymptomatic patients

A direct comparison between demographics of asymptomatics versus symptomatics is shown in Table 5.

Table 5 : Demographic comparison between asymptomatic and symptomatics

Variable	Asymptomatic	Symptomatic	P
Number of cases	3383	810	
Male	64.6%	68.3%	0.048
Age (95% CI)	67.5 (67.2-67.8)	68.5 (67.9-69.1)	0.004
CAD%	17.8%	17.1%	NS
HTN%	40.1%	39%	NS
COPD%	6.9%	6.3%	NS
Diabetes%	15.8%	18.4%	0.08
Renal Failure%	3.4%	3.7%	NS
Smoker%	5.6%	5.4%	NS

Symptomatic patients seem to be slightly older with a higher proportion of males. Comparison of outcomes between these two cohorts is described in table 6.

Table 6: Outcome comparison between symptomatic and symptomatic patients

Outcome	Asymptomatic	Symptomatic	P
Stroke rate%	4.4%	10.24%	<0.001
MI rate%	1.6%	3.5%	<0.001
Death rate%	0.95%	1.1%	NS
Length of stay (days)	6.8 days	9.9 days	<0.001 ind. t-test

Symptomatic patients have a higher rate of post-operative stroke and MI and also have a longer mean length of stay.

(3) **Comparison of Outcomes Between Surgical Specialties**

A comparison between surgical specialties is displayed in Table 7 and Table 8.

Table 7: Demographic Differences Between Specialties

Characteristic	Vascular surgery	General Surgery	Neurosurgery	p
Age(yrs)	67.6	67.9	68.0	NS
Male%	64.4%	63.0%	70.4%	0.001
CAD%	19.6%	8.8%	24%	<0.001
HTN%	34.2%	43.9%	48%	<0.001
COPD%	5.8%	7.6%	8.5%	0.026
Diabetes%	14.5%	16.9%	19.6%	0.002
Renal Failure%	3.1%	3.6%	4.1%	NS
Smoker%	6.8%	5.3%	3.6%	0.002

Neurosurgeons operate on more males. The cohort of patients operated on by neurosurgeons have a higher incidence of most risk factors, however vascular surgeons operate on significantly more smokers.

Table 8: Outcomes between specialties

Outcome	Vascular Surgery	General Surgery	Neurosurgery	P
Stroke%	5.0%	4.6%	7.9%	0.002
MI%	2.5%	1.2%	1.6%	0.013
Death	1.2%	1.1%	0.32%	0.034

Post-operative stroke rate is highest amongst the neurosurgery cohort, however this group have a relatively low death rate. Vascular patients have a higher rate of post-operative myocardial infarction and peri-operative death.

(4) Comparison of Teaching and non-teaching hospitals

A comparison of patient demographics amongst patients operated on in a teaching institution versus a non-teaching institution is displayed in table 9.

Table 9: Demographics in teaching and non-teaching institutions

Characteristic	Teaching	Non-teaching	P
Number of cases	2869 (68.4%)	1324(31.6%)	
Age	67.7	67.8	NS
Male%	66.1%	63.6%	0.1
Symptomatic%	20.3%	17.2%	0.02
CAD%	16.6%	18.6%	0.1
HTN%	37.4%	46.3%	<0.001
COPD%	6.0%	8.5%	0.004
Diabetes%	15.6%	17.4%	0.2
Renal Failure%	3.7%	3.1%	NS
Smoker%	5.1%	6.7%	0.04

Table 10 is a comparison of outcomes between surgical specialties within the teaching and non-teaching hospitals.

Table 10: Outcomes between specialties with teaching and non-teaching

Specialty	Teaching	Non-teaching	P
Vascular surgery	78% (1540)	22%(432)	<0.001
General Surgery	52.9%(683)	47.1%(610)	<0.001
Neurosurgery	69.7%(646)	30.3%(282)	<0.001
P	<0.001	<0.001	

Vascular surgeons operate predominantly in teaching institution. General surgeons who perform vascular surgery perform the most number of CEA in non-teaching hospitals.

Table 11: Outcome in teaching and non-teaching hospitals.

Outcome	Teaching	Non-teaching	p
Stroke%	5.4%(156)	5.7%(75)	NS
MI%	2.2%(63)	1.3%(17)	0.05
Death%	0.98%(28)	0.98%(13)	NS
LOS	7.2 days	6.9 days	NS

As demonstrated by table 11, there is no difference in outcome between teaching and non-teaching hospitals except for peri-operative myocardial infarction which is more common amongst patients operated on in a teaching hospital.

Multi-variate analysis models

To compliment the previous analyses, logistic regression models are used to evaluate risk factors for the outcomes of stroke, myocardial infarction, death and prolonged length of stay. Before embarking on this complex analysis, we complete our stratified analysis in order to choose appropriate variables to be included in each logistic regression model. Table 12 summarizes potential confounding factors for the outcomes and highlights those that will be used in the multivariate analysis. Those demographic factors that significantly affect the outcome under univariate analysis are included in the multivariate model.

Table 12: Assessment of confounding factors

SEX	Male(n=2738)	Female(n=1455)	P
Stroke%	5.7%(156)	5.2%(75)	NS
MI%	1.8%(48)	2.2%(32)	NS
LOS>4 days	51.9%(1420)	54%(791)	0.1
Death%	0.78%(21)	1.4%(20)	0.043
AGE	Age>75(n=759)	Age<76(n=3434)	P
Stroke%	5.4%(41)	5.5%(190)	NS
MI%	2.5%(19)	1.8%(61)	0.19
LOS>4 days	63%(479)	50.4%(1732)	<0.001
Death%	1.5%(11)	0.87%(30)	0.15

CAD	CAD+(721)	CAD-(3472)	P
Stroke%	6.5%(47)	5.3%(184)	0.2
MI%	4.6%(33)	1.4%(47)	<0.001
LOS>4 days	55.3%(399)	52.2%(1812)	0.13
Death%	1.8%(13)	0.8%(28)	0.02
HTN	HTN+(n=1687)	HTN-(2506)	P
Stroke%	6.4%(108)	4.9%(123)	0.04
MI%	2.1%(36)	1.8%(44)	NS
LOS>4 days	53%(896)	52.4%(1315)	NS
Death%	1.4%(24)	0.68%(17)	0.02
COPD	COPD+(N=285)	COPD-(N=3908)	P
Stroke%	7.7%(22)	5.4%(209)	0.1
MI%	2.8%(8)	1.8%(72)	NS
LOS>4 days	61.4%(175)	52%(2036)	0.003
Death%	0.7%(2)	1.0%(39)	NS
RENAL FAILUR	Renal fail+(n=146)	Renal Fail-(4047)	P
Stroke%	8.2%(12)	5.4%(219)	0.14
MI%	4.5%(7)	1.8%(73)	0.02
LOS>4 days	69%(101)	52%(2110)	<0.001
Death%	4.8%(7)	0.84%(34)	<0.001
DIABETES	Diabetes+(n=685)	Diabetes-	P
Stroke%	6.3%(43)	5.4%(188)	NS
MI%	2.5%(17)	1.8%(63)	0.2
LOS>4 days	54%(368)	52.5%(1843)	NS
Death%	1.2%(8)	0.94%(33)	NS
SMOKING	Smoker+(n=235)	Smoker-(3985)	P
Stroke%	9.4%(22)	5.3%(209)	0.012
MI%	2.4%(7)	1.8%(73)	NS
LOS>4 days	43.0%(101)	53%(2110)	0.002
Death%	0.85%(2)	0.99%(39)	NS

Using the results from the previous analysis, we performed multivariate analysis for the four outcomes controlling for factors that have a statistically significant impact on the outcome.

Table 13: STROKE

OR= Odds Ratio

Variable	OR (95% CI)	P-value
Neurosurgery	1.73 ((1.29-2.31)	0.002
Symptoms	2.44(1.84-3.24)	<0.001
HTN	1.29(0.98-1.70)	0.065
Smoker	1.96(1.22-3.12)	0.005

After controlling for co-morbidities and the higher incidence of symptomatic patients, patients operated on by neurosurgeons have a higher risk of post-operative stroke.

Table 14: Myocardial infarction

Variable	OR (95%CI)	P-value
Vascular surgeons	1.70 (1.05-2.70)	0.03
Symptoms	2.0(1.24-3.23)	0.005
Teaching	1.52(0.87-2.65)	0.14
CAD	3.35(2.12-5.3)	<0.001
Renal Failure	2.6(1.15-5.82)	0.02

Being operated on by a vascular surgeon is an independent risk factor for per-operative myocardial infarction. University status no longer remained a risk factor when using multivariate analysis to control for confounders.

Table 15: DEATH

Variable	OR(95% CI)	P-value
Vascular Surgery	1.48(0.77-2.82)	0.23
Female	1.6(0.85-3.0)	0.14
CAD	2.0(1.05-3.86)	0.03
MI	15.2 (6.9-33.3)	<0.001
HTN	1.58(0.78-3.2)	0.20

Vascular surgery does not remain a significant risk factor for mortality following CEA.

Table 16: Length of stay > 4 days

Variable	OR(95% CI)	P-value
Neurosurgery	2.97(2.52-3.51)	<0.001
Age>75	1.62(1.38-1.92)	<0.001
MI	4.02(2.27-7.14)	<0.001
Smoker	0.70(0.53-0.93)	0.012
COPD	1.40(1.07-1.80)	0.01
Stroke	4.33	<0.001

83% of patients who suffered a stroke remained in hospital for more than 4 days. However, even after adjusting for post-operative stroke and other risk factors, Neurosurgery remained an independent risk factor.

In preparation of this thesis two manuscripts for publication have been written, both corresponding to two topics already analysed in the results section. The first, which was submitted to a French journal, addresses the alarming rate of decline of the CEA between 1996 and 1999 in the Province of Quebec. A discussion of this decline is also included in English in the main body of the Thesis. The second topic is a comparison of surgical specialties, specifically the General Surgeon, Vascular Surgeon, and the Neurosurgeon. This manuscript has been submitted to an English Vascular surgery Journal.

Both manuscripts are awaiting acceptance.

Le taux d'endartériectomie carotidienne au Québec a-t-il été influencé par NASCET, ACAS et les consensus nord-américains ?

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1. INTRODUCTION

Les accidents vasculaires cérébraux (AVC) sont la troisième cause de mortalité en Amérique du Nord et la deuxième cause de mortalité reliée au système cardio-vasculaire. Ils ont un impact majeur sur le système de santé nord-américain puisque le patient victime d'un infarctus cérébral peut, s'il survie, demeurer handicapé d'une façon plus ou moins sévère et/ou chronique. En plus des coûts humains, les coûts économiques directs et indirects des AVC sont donc faramineux et étaient évalués à 45.4 milliards de dollars aux États-Unis en 2001 (1-4).

Le traitement chirurgical des sténoses carotidiennes symptomatiques et asymptomatiques s'est avéré efficace dans la prévention de l'AVC à l'intérieur de deux études cliniques randomisées nord-américaines : NASCET et ACAS (5-6). Dans ces études, les chercheurs ont démontré une réduction statistiquement significative du taux d'AVC à long terme dans le groupe traité chirurgicalement par rapport au groupe traité médicalement. Le résultat de ces études a été largement diffusé et ont entraîné une augmentation du taux de CEA. Cependant, une controverse nord-américaine existe à savoir si à l'extérieur des études contrôlées, il est possible d'obtenir les mêmes résultats (7-8). En d'autres mots, est-ce que les patients choisis dans la population en général obtiennent une protection contre l'AVC en subissant une endartériectomie carotidienne (CEA) ? La question n'est pas simple en Amérique du Nord puisque des consensus ont été publiés au Canada et ils étaient contradictoires avec ceux aux États-Unis.

Cet article examine le taux de CEA au cours de la dernière décade dans la province de Québec, en relation avec la publication de NASCET et ACAS ainsi que les consensus canadiens et américains. De plus, une revue de la littérature a été faite pour comparer les taux de CEA au Québec par rapport au reste du Canada et des Etats-Unis.

II. Méthode

Description des données des CEA au Québec

Feuille sommaire (Med-Echo)

La méthode de notre étude est rétrospective. Nous avons construit des cohortes de patients ayant subi une endartériectomie carotidienne entre le 1er janvier 1991 et le 31 décembre 1999. En utilisant Med-Echo nous avons identifié les patients ayant subi une CEA basé sur le code 50.12 de ICD-9. Ceci exclut les patients ayant subi une procédure cardiaque simultanément.
En utilisant les données démographiques de la province de Québec fournies par « Statistiques Canada », nous avons calculé des taux de CEA ajustés pour le sexe et l'âge par 100 000 de population âgés de plus de 40 ans.

Description des données des CEA au Canada et États-Unis

Pour obtenir de l'information sur la publication des consensus canadiens et américains de même que de l'information sur les taux de CEA en amérique du Nord, une recherche par la banque de données Medline a été effectuée (1990- à présent) en utilisant les mots : carotid endarterectomy, epidemiology, rates, consensus.

III. Résultats

Taux de CEA au Québec

Entre 1991 et 1999, 10 870 procédures ont été réalisées au Québec. Nous avons constaté qu'entre 1991 et 1997, il y a eu une augmentation du taux de CEA au Québec. La première augmentation en 1991 correspond à la publication du NASCET et la deuxième augmentation avec celle de ACAS en 1994. En 1991, le taux était de 25/100,000 de population de plus de 40 années pour atteindre un sommet à 44.3/100,000 en 1996. Cependant, il y a eu une diminution de 10.7% entre 1997 et 1999. Le taux était légèrement inférieur à 40/100,000 en 1999 (graphique 1)

Taux de CEA au Canada et aux États-Unis

Deux études canadiennes ont permis de connaître les taux dans les provinces canadiennes. L'étude du Dr. Tu (9) qui inclut la période de 1984-1995 puis celle de Feasby (10) période de 1994-1997 ont toutes deux démontré des taux identiques en Ontario de 1994-1997. En 1997, le taux québecois est comparable à celui de l'Ontario, province canadienne voisine du Québec.

Dr. Gillum (11) a publié les taux de CEA aux Etats-Unis jusqu'en 1996 et il était évalué à 130/100,000 de population âgée de plus de 40 ans. Le taux au Québec reste en tout temps bien inférieur au taux américain qui a en fait augmenté de 94% entre 1991 et 1996. Le taux québécois en 1996 était de 44.3/100,000 alors qu'en Floride il était de110.8/100,000 selon l'étude du Dr. Morasch (12).

Études et Consensus nord-américains ayant pu avoir une influence sur les taux de CEA au Québec entre 1991 et 1999

NASCET (1991) :

Janvier 1988 à février 1991. Près de 4000 patients évalués et 662 patients sélectionnés (N=331 groupe médical et N=328 groupe chirurgical). . L'analyse des tables de survie ont démontré un risque cumulatif d'AVC ipsilatéral à deux ans de 26% pour le groupe traité médicalement et de 9% pour le groupe traité médicalement et avec CEA. Ceci correspond à une réduction absolue d'AVC de 17%.

SVS (1992):

Report of the Committe to the join Council of the Society of Vascular Surgery recommande la CEA pour une sténose symptomatique de la carotid interne de plus de 70% (13).

ACAS (1995):

Décembre 1987 à décembre 1993 : 42, 000 patients évalués et 1662 randomisés. En septembre 1994, le comité « advisory » recommande Dans le cas des sténoses asymptomatiques de 60 % et plus, l'ACAS a montré un maigre avantage à la chirurgie par rapport au traitement médical intensif seul. Il s'agit d'une réduction de 55% du risque absolu d'AVC à 5 ans.

Les publications du Dr. Barnett :

Le principal investigateur du NASCET, le Dr. Henry Barnett, un canadien, a publié de nombreux articles s'opposant à l'endartériectomie carotidienne pour la sténose carotidienne asymptomatique (14-15).

Consortium des neurologues et neurochirurgiens canadien (1997):
Les neurologues canadiens ont rejeté l'indication d'une chirurgie prophylactique de la sténose carotidienne asymptomatique. Le titre de leur publication ne pouvait être plus clair : « Consensus against both endarterectomy and routine screening for asymptomatic carotid artery stenosis » (16). Il est intéressant de noter que certains de ces neurologues avaient participer à ACAS. Les neurochirurgiens considéraient l'indication des CEA pour les sténoses asymptomatiques incertaines (17).

American Heart Association (1998):
En 1998, la sténose carotidienne asymptomatique devenait pour l'American Heart Association une indication absolue d'opérer (« proven indication ») en autant que le taux pré-opératoire de complications soit inférieur à 3% et l'espérance de vie supérieur à 5 ans (18).

Chirurgiens vasculaires canadiens (1998):
Les chirurgiens vasculaires considéraient l'indication des CEA pour les sténoses asymptomatiques incertaines (19).

IV. Discussion

Le taux d'endartériectomie carotidienne d'une région à l'autre a fait l'objet de plusieurs études. La variation de ces taux est la plus souvent associée à la possibilité d'améliorer l'accessibilité, l'utilisation et les résultats de la CEA. La relation entre les taux de CEA et les publications des consensus canadiens et américains n'a cependant jamais fait l'objet d'étude. Ce sujet est intéressant puisque les deux études importantes soit NASCET et ACAS ont été réalisé au Canada et aux États-Unis mais les recommandations émergeants de ces deux études étaient différents dans les deux pays. Un lien peut donc aussi exister entre le taux de CEA et la façon dont des systèmes de santé différents réagissent à la même littérature. De plus, il nous apparaît essentiel de comprendre comment des consensus différents émergent des mêmes deux études multicentriques contrôlées et randomisées.

En 1991, il n'y a aucun doute que la publication du NASCET a entraîné une augmentation du taux de CEA des deux côtés de la frontière. . Le principal investigateur du NASCET, le Dr. Barnett , a démontré aux chirurgiens mais aussi aux neurologues la supériorité de la CEA par rapport au traitement médical seul ce qui était l'objet d'une controverse durant les années 80. Après cette publication, il n'y a plus de littérature s'opposant à la CEA pour les patients répondant aux critères du NASCET. Ces critères sont cependant nombreux et touchent à la fois les chirurgiens pratiquant la CEA et aussi les patients sélectionnés.

La mortalité et la morbidité péri-opératoires des chirurgiens qui voulaient participer à NASCET étaient évaluées et devaient atteindre certains standards. Les patients étaient aussi choisis selon des critères bien préçis : ils devaient avoir présenté un symptôme neurologique (ICT, AVC ou amaurose fugace) en dedans d'une période de 120 jours et une lésion de la carotide interne de plus de 70%. Le diagnostic devait être basé d'abord sur un échographie doppler couleur puis sur une angiographie cérébrale. Cette angiographie était révisée par un comité central avant la randomisation. Les patients ayant subi un AVC devaient avoir une absence de déficit neurologique résiduel ou un déficit neurologique minimal. Toutes les autres étiologies d'AVC devaient être éliminées (embolies d'origine cardiaque, coagulopathie, etc.). Enfin, chaque patient sélectionné pour la CEA devait avoir tous les facteurs de risque évalués et contrôlés : ceci incluait la cessation du tabagisme, le contrôle de l'hypertension artérielle, du diabète, de l'hypercholestérolémie, de l'index de masse corporelle et de la maladie cardiaque athérosclérotique. Les critères d'exclusion étaient nombreux et variés : par exemple, les patients qui ne devaient pas être opérés pour une sténose symptomatique de plus 70% étaient ceux avec un risque opératoire élevé et/ou une espérance de vie limitée (un cancer susceptible d'entraîner un décès à cinq ans était un critère d'exclusion). L'âge plus grand que 80 ans était un critère d'exclusion. Enfin, aucun patient n'a été perdu au suivi.

En 1995, la publication de l'ACAS, qui est aussi une étude nord-américaine mais cette fois dirigée par un américain, entraîne un enthousiasme aux États-Unis avec une augmentation importante des taux de CEA. Le taux de CEA au Québec augmente lors de la publication de l'ACAS ce qui a aussi été observé dans le reste du Canada. Cependant, dès 1997, le taux au Québec commence à fléchir, alors qu'il continue à augmenter aux États-Unis. Pourquoi ?
Nous soulevons plusieurs hypothèses.

L'ACAS n'a montré qu'un maigre avantage à la chirurgie par rapport au traitement médical intensif seul. Il s'agit d'une réduction de 55% du risque absolu d'AVC à 5 ans. En d'autres termes, le risque qu'une sténose asymptomatique traité médicalement provoque un AVC à 5 ans est de 11.0% alors qu'après une CEA un patient a 5.1% de subir un AVC. C'est une réduction de 1% par année. Les candidats choisis pour le traitement chirurgical doivent présenter une sténose de 60% à l'angiographie et une espérance de vie de plus de 5 ans. Dans cette étude, les femmes n'avaient pas davantage à la chirurgie. Finalement les chirurgiens étaient « exceptionnellement » doués n'ayant que 2.1% de mortalité et morbidité combinées.

Le Dr. Barnett et un groupe influent de neurologues canadiens se sont opposés à ce que ACAS puisse justifier la CEA pour les patients asymptomatiques, l'avantage de la CEA par rapport au traitement médical seul étant minime voire inexistant et cela pour deux raisons.
Premièrement, dans l'ACAS très peu de patients évalués (44,000) étaient finalement randomisés (1600). Le processus de sélection des patients est donc la première démarche à l'obtention de résultats avantageux de l'endartériectomie carotidienne chez le patient asymptomatique. De plus, il faut faire 7 CEA pour prévenir un AVC pour les sténoses symptomatiques

alors qu'il faut faire 80 CEA pour prévenir un AVC chez les patients asymptomatiques. Le coût-bénifice est donc de beaucoup réduit. Au niveau de la santé publique, il est peu avantageux de procéder à une CEA pour une sténose asymptomatique comparé par exemple au contrôle de l'hypertension artérielle (20).

Deuxièmement, il a été bien démontré que les publications de ces deux études ont entraîné un changement dans la pratique médical, mais que ces changements étaient extrapolés à des patients et des environnements qui n'étaient pas supportés par ces études randomisées (21-22). Par exemple, est-il acceptable d'opérer les patients âgés de plus de 80 ans ? Est- ce que les femmes ayant une sténose asymptomatique devrait être opérées ? Est-ce que les chirurgiens qui réalisent les CEA ont les mêmes taux de mortalité et de morbidité que ceux des études ACAS et NASCET ? Est-ce que les centres à bas volume de cas peuvent obtenir les mêmes résultats que les centres à haut volume ? Toutes ces questions soulèvent un doute certain tant qu'à l'efficacité de la CEA dans la pratique courante en particulier pour la sténose asymptomatique (23). Les neurologues canadiens ont donc développer une attitude différente face à la sténose carotidienne par rapport aux neurologues américains (24).

Nous pensons que ce sont ces raisons qui sont responsables de la chute du taux de CEA au Québec après 1997. Le consensus de l'AHA de 1998 n'a donc pas entraîné une augmentation du taux de CEA au Québec.

A travers ces controverses, deux concepts font cependant l'unanimité :

1- Les résultats de l'endarteriectomie carotidienne obtenus dans tous les centres qui pratiquent cette chirurgie doivent être étudiés et connus.
2- C'est à partir de ces données objectives, que l'amélioration des résultats est possible.

À cet égard, le leadership de l'État de New York est éloquent. En 1989, le département de la Santé a recueilli, analysé et fait connaître les résultats des pontages coronariens pour chacun des 30 hôpitaux offrant la procédure cardiaque. Entre 1989 et 1992, le nombre de procédures cardiaques a augmenté de 12,269 à 16,028 alors que le taux de mortalité chutait de 3.5% à

2.8% et que l'index de sévérité de la maladie augmentait de 2.6% à 3.5% (25).

Cet exemple a été imité pour la CEA. Dans l'état du Iowa, après avoir analysé et fait connaître les résultats de la CEA, le taux péri-opératoire de mortalité et d'AVC a passé de 7.8% en 1994 à 4.0% en 1996 (26). En Grande-Bretagne, un projet similaire a débuté en 1998 (27).

Notre intention est de poursuivre notre étude de la CEA de la province de Québec. Avec l'expérience favorable obtenue dans l'État de New York et de l'Iowa, nous pensons qu'une meilleur connaissance de la CEA tel qu'elle se pratique au Québec est le meilleur moyen de maximiser les résultats favorables. Chaque hôpital aurait donc à faire son prope « consensus » sur la pratique de la CEA. . Pour les mêmes raisons nous ne pensons pas que l'étude européenne portant sur la CEA et qui sera publiée prochainement aura un impact sur le taux de CEA au Québec(28-32).

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Impact of surgical specialty on outcome following carotid endarterectomy

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IMPACT OF SURGEON SPECIALTY ON THE OUTCOME OF CAROTID ENDARTERECTOMY: AN ANALYSIS OF 4 193 PATIENTS IN QUEBEC

Objective: To determine the independent impact of surgical specialty (vascular, neurosurgery, general surgery) on in-hospital morbidity and mortality following carotid endarterectomy (CEA).
Patients and Methods: The Quebec Discharge Summary Database (Med-Echo) provided hospital data on all CEAs performed from 1997 to 1999 (n=4193) to evaluate the influence of surgeon's specialty on the rate of peri-operative stroke, myocardial infarction, and death. Patient characteristics between the neuro-, vascular, and general surgery cohorts were compared.

Results:

Variable	Vascular	General	Neurosurgery	P
Cases (%)	1972 (47%)	1293 (30.8%)	928(22.1%)	-
Age (IQR)	67.6(62-74)	67.9(62-74)	68.0(62-74)	NS
Male (%)	1270(64.4%)	815(63.0%)	653(70.4%)	0.001
Stroke rate	5.0%(98)	4.6%(60)	7.9%(73)	0.002
MI rate	2.5%(50)	1.2%(15)	1.6%(15)	0.013
Death OR (95% CI)	1.00	0.92(0.45-1.89)	0.23(0.070-0.77)	0.017†
Stroke OR (95% CI)	1.00	0.96(0.68-1.34)	1.55(1.12-2.13)	0.008†

IQR=Interquartile range, OR=Odds ratio, †neuro vs vascular surgery(logistic regression)

After the adjustment for potential confounding factors of age, sex, pre-operative symptoms, co-morbid illnesses, the odds of post-operative stroke was 55% higher when the CEA was performed by a neurosurgeon than when it was by a vascular surgeon, however the odds of death was 77% higher in the vascular surgery cohort. Conclusion: Patients who undergo CEA performed by a vascular surgeon have significantly lower stroke rates despite a higher mortality than patients who are operated on by a neurosurgeon. The higher death rate may be due to a higher rate of myocardial infarction. Technical experience with vascular procedures may explain the lower stroke rate amongst the vascular cohort. A limitation of this study is the inherent inability to accurately control for all confounders in the administrative database.

Introduction

Carotid endarterectomy (CEA) is the most commonly performed peripheral vascular procedure in the United States[1]. Since the first carotid endarterectomy was performed in 1954[2], many studies have identified patient and surgeon characteristics that influence the rate of post-operative stroke and mortality[3-6]. Vascular surgeons, general surgeons, and neurosurgeons participated in the influential North American Symptomatic Carotid

Endarterectomy (NASCET) and the Asymptomatic Carotid Atherosclerosis Study (ACAS)[7,8] however no subgroup analysis was performed comparing outcomes between these specialties. To address whether surgical specialty training influences outcome and rates, we conducted a population-based study of the results of all CEAs performed in the province of Quebec, Canada, over a 3 year period.

Materials and Methods

A database of patients undergoing CEA between 1996-1999 was obtained from MED-ECHO, an anacronym for Maintenance et Exploitation de Donnees pour L'Etude de la Clientele Hospitaliere. It is a computer based information retrieval system run by the Ministere de la Sante et des Services Sociaux of the province of Quebec. Discharge information on each hospitalised patient in Quebec was coded using ICD-9[TH] edition and electronically sent from the treating hospital to the MED-ECHO database. Once centralized, the data was filtered for possible errors. Each variable was validated individually by ensuring that an appropriate code is entered. If a code appeared to be misplaced, the file was returned to the hospital for corrections. All patients who had the code 50.12 (Hospitalised patients who underwent a carotid endarterectomy) were included in the database. This does not include patients who underwent concomitant coronary artery bypass surgery. Variable included for each case in the database were: patient age, sex, co-morbid illnesses, presence of previous stroke of transient ischemic attacks (TIAs), length of stay (LOS), in-hospital death or stroke, post-operative myocardial infarction, name of hospital and specialty of surgeon. Since vascular surgery is not a recognized subspecialty in Quebec, they are classified as cardiovascular and thoracic surgeons. General surgeons who performed CEAs were those who were not certified by the Royal College of Physicians and Surgeons as vascular surgeons. Neurosurgery was the third specialty that performed the CEA in Quebec. The type of hospital where each hospital was performed was classified into a teaching or a non-teaching hospital using information from the Quebec Hospital Association. All hospitals that maintained an official affiliation with a Quebec university were considered as “teaching”. ICD-9th edition did not provide anatomic location, degree of stenosis, name of operating surgeon, or details about the surgical technique.

Statistical Analysis

Initially, a univariate analysis was performed. Categorical variables, such as gender, hypertension, diabetes mellitus, COPD, renal disease, heart disease, and presence of pre-operative symptoms were compared between the three specialties by chi-square analysis. The proportion of cases performed by each specialty as well as in-hospital stroke, myocardial infarction, and death rates were also analysed using the chi-square test. Continuous variables such as age and average LOS were compared using the independent t-test. The independent influence of surgical specialty on outcomes after adjusting for type of hospital, gender, age, and cormorbidities, were examined by multiple logistic regression. The three outcomes examined using multivariate analyses included, per-operative death, stroke, and myocardial infarction. The SPSS® statistical package was used to conduct all the analysis.

Results

Patients operated on by a neurosurgeon had a higher prevalence of comorbidities Table 1. They were also more likely to be male and symptomatic. Vascular surgical patients had a higher prevalance of smoking. The neurosurgery cohort had a significantly higher LOS.

During the study period there was a 10.6% decline in the rate of CEAs performed. Vascular surgeons performed 47% of CEAs, 31% by general surgeons, and 22% were performed by neurosurgeons (Table 2). Over the three years, there was a 16% reduction in proportion of CEAs performed by vascular surgeons despite a 34% increase from neurosurgeons.

Vascular surgeons perform a significantly higher number of their CEAs in a teaching institution when compared with other specialties. General surgeons perform almost half of their procedures in non-teaching institution (Table 3). Crude outcome rates for the three surgeon specialties are shown in table 4.

Both in-hospital stroke (R=0.188, P<0.001) and myocardial infarction (R=0.166, P<0.001) had a positive correlation with death. Death rates following stroke are shown in Table 4

Following a stroke vascular surgery patients have a higher in-hospital mortality when compared to the general and neurosurgical surgery cohorts. The multivariate odds ratios for post-operative stroke or death following CEA by type of surgeon and other factors are shown in Table 5.

After the adjustment for potential confounding factors of age, sex, pre-operative symptoms, co-morbid illnesses, the odds of post-operative stroke was 55% higher when the CEA was performed by a neurosurgeon than when it was by a vascular surgeon, however the odds of death was 77% higher in the vascular surgery cohort.

A similar multiple logistic regression model was performed as post-operative myocardial infarction as the outcome. Table 6

Independent risk factors for post-CEA myocardial infarction include age, pre-operative symptoms, coronary artery disease and renal insufficiency Surgical specialty had no affect on risk of myocardial infarction.

Discussion

An exhaustive MEDLINE search revealed no publications comparing the results of different surgical specialties performing CEA. In the ACAS trial 84% of enrolled surgeons were vascular surgeons and the rest were neurosurgeons[9], however no data was published comparing these two specialties. In Quebec, 47% of CEA were performed by vascular surgeons, 31% by general surgeons, and 22% performed by Neurosurgeons. Over the three years, there was a reduction in proportion of CEAs performed by vascular surgeons despite a significant increase from neurosurgeons. Being operated on by a neurosurgeon remained an independent risk factor for peri-operative stroke after controlling for co-orbid conditions. Vascular surgeons had a higher post-opeative MI rate when compared to neurosurgeons however this increased risk did not remain significant following multivariate analysis.

After controlling for multiple variables the post-operative relative risk of stroke remained significantly higher for the neurosurgery cohort. Possible explanations include: (1) The inability to adequately control for the higher proportion of symptomatics amongst neurosurgeons or (2) technical differences and use of the vascular lab per-operatively between specialties. (3) Different sensitivities between specialties in diagnosing post-operative stroke.

Pre-operative symptoms is an accepted risk factor for post-operative stroke. Using the MED-ECHO database we attempt to identify all patients who have a neurological event as a primary or secondary diagnosis. This identified only 810 (19%) patients. Most prospective and chart review studies which do not rely on administrative data have a significantly larger proportion of symptomatic patients. In a recent audit of 678 Medicare patients in Ohio, 52.5% were symptomatic.[10] At our institution (CHVO) 45/96 (47%) of patients operated on between 1997-1999 were symptomatic however, the database revelealed only 14 of the 45 patients (15%). Overall in our database about 19% of the patients were identified as symptomatic, likely an underestimation of the true proportion. Even though we attempt to compensate for the higher stroke rate in symptomatic patients using multivariate analysis, this may be incomplete. A higher than expected stroke rate amongst neurosurgeons may be partially due to a higher proportion of symptomatic patients in this cohort.

Similarly, the neurosurgery cohort had higher prevalence of co-morbidities which is likely secondary to observation bias. The higher risk of post-operative MI and death amongst vascular surgical patients may be partially explained by an underestimation of comorbidities in this group therefore preventing us from accurately controlling for confounders. Therefore, because we used admistrative data, we did not have complete information on the clinical characteristics of the patients.

Secondly, vascular surgeons may have a distinct technical advantage over neurosurgeons in performing CEAs because of the larger volume of vascular surgery that they perform. Neurosurgeons have to develop not only skills to perform an endarterectomy but many other types of opereations and therefore they may have less time to gain expertise in vascular procedures. It has been shown in numerous studies that surgeons with high volumes have better outcomes for ruptured aneurysms and CEAs[11-14]. Also surgeons with a greater proportion of their practice in vascular surgery had better outcomes with ruptured aortic aneurysms. Vascular surgeons not only perform endarterectomies on the carotid but also on arteries throughout the body while neurosurgeons perform endarterectomies solely on extracranial circulation. The resultant higher number of endartrectomies performed may provide the necessary experience to maintain a low stroke rate.

The vascular surgeons easier access to the vascular lab may result in the increased use of the intra-op Doppler following carotid reconstruction which has been shown to reduce peri-operative stroke rates[15,16]. Eventhough we cannot quantify this with our database it seems likely that the vascular surgeons comfort with the use of the Doppler may reduce incidence of post-op stroke.

Finally, the diagnosis of post-operative stroke may vary between specialties. In a review of 51 studies of carotid endarterectomy for asymptomatic stenosis, stroke rates were highest in studies in which the patient was assessed by a neurologist after surgery (7.7%).[17] Similarly neurosurgeons may be more sensitive in their post-operative surgical assessment and therefore may report a higher stroke rate when compared to vascular surgeons.

The Med-ECHO database does not allow analysis of outcomes from individual surgeons. We, therefore, do not know the number of cases performed by each surgeon per year. The relationship between volume and outcome has been shown to positively affect results. This prevents us from matching surgeons of different specialties who have similar volumes allowing us to have a more accurate comparison between specialties.

We based our classification on the category that the surgeons is usually coded with. This may classify older general surgeons who received vascular surgery training as general surgeons because the specialty of vascular surgery was not recognized by the Royal College of Surgeons of Canada until 1981. Even though these older surgeons have a predominantly vascular practice they are still classified as general surgeons. Interestlingly, their outcomes are very much the same as the vascular surgery cohort. Therefore, there may have been some misclassification between the general surgeon and vascular surgeon cohorts. However, whether they are separate or combined, their outcomes are significantly different from the neurosurgeons.

In summary, patients who undergo CEA performed by a vascular surgeon have significantly lower stroke rates despite a higher mortality than patients who are operated on by a neurosurgeon. The higher death rate may be due to a higher rate of myocardial infarction. Technical experience with vascular procedures may explain the lower stroke rate amongst the vascular cohort.

This data may have important implications, however, it should not be used to deny neurosurgeons with excellent surgical outcome the opportunity to perform this vascular procedure.

Table 1. Characteristics of patients divided by type of surgeon

Characteristic	Vascular surgery	General Surgery	Neurosurgery	p
Cases	1972 (47%)	1293 (30.8%)	928(22.1%)	
Age (yrs) (IQR)	67.6(62-74)	67.9(62-74)	68.0(62-74)	NS
LOS (days) (95% CI)	6.4 (6.1-6.7)	6.8(6.5-7.2)	9.0 (8.5-9.6)	
Male%	1270(64.4%)	815(63.0%)	653(70.4%)	0.001
CAD%	387(19.6%)	114(8.8%)	220(24%)	<0.001
HTN%	674(34.2%)	567(43.9%)	446(48%)	<0.001
COPD%	115(5.8%)	91(7.6%)	79(8.5%)	0.026
Diabetes%	285(14.5%)	218(16.9%)	182(19.6%)	0.002
Renal Failure%	61(3.1%)	47(3.6%)	38(4.1%)	NS
Smoker%	134(6.8%)	68(5.3%)	33(3.6%)	0.002
Symptoms%	386 (19.6%)	215 (16.6%)	209(22.5%)	0.002

IQR= Interquartile range, LOS= Length of stay

Table 2: Age and sex standardized rates of CEA in Quebec between specialties

Group	1996-1997 CEA/100 000 (%)	1997-1998 CEA/100 000 (%)	1998-1999 CEA/100 000 (%)	Change (96-99) CEA/100 000 (%)	p Chi^2
Overall	44.3 (100)	43.8 (100)	39.6 (100)	4.7	
Vascular	22.7 (51.2)	20.3 (46.3)	17.1 (43.2)	-5.6 (-15.6)	<0.001
General	13.6 (30.7)	13.5 (30.8)	12.3 (31.1)	-1.3 (-1.3)	NS
Neurosurgery	7.4 (16.7)	9.4(21.5)	9.9 (25)	+2.5 (+33.7)	<0.001

Table 3: University distribution of specialties

Specialty	Teaching
Vascular surgery	78% (1540)
General Surgery	52.9%(683)
Neurosurgery	69.7%(646)
Total	68.4%(2869)
P	<0.001

Table 4: Crude In-hospital rates of complications following CEA

Outcome	Vascular Surgery	Genaral Surgery	Neurosurgery	p
Stroke%	5.0%(98)	4.6%(60)	7.9%(73)	0.002
MI%	2.5%(50)	1.2%(15)	1.6%(15)	0.013
Death	1.2%(24)	1.1%(14)	0.32%(3)	0.067

Table 4: In-hospital mortality following post-operative stroke (1997-1999)

	Vascular Surgery	General Surgery	Neurosurgery	Chi-square
# of post-operative strokes	98	60	73	
Death rate following stroke	13.3% (13)	8.0%(5)	2.7%(2)	0.05

Table 5: Multivariate logistic regression model to identify predictors of post-operative stroke and death following CEA

Variable	STROKE			DEATH		
	OR	95% CI	P	OR	95% CI	P
Specialty						
Neurosurgery	1.55	1.12-2.12	<0.01	0.23	0.08-0.77	0.02
General	0.94	0.67-1.32	0.71	0.92	0.45-1.89	0.83
Vascular	1.00			1.00		
University	0.93	0.69-1.23	0.64	1.07	0.53-2.16	0.86
Patient						
Age 65-74	0.99	0.73-1.35	0.96	5.23	1.57-17.5	0.01
Age >74	0.97	0.67-1.41	0.88	5.24	1.48-18.6	0.01
Female	0.93	0.70-1.25	0.62	1.94	1.02-3.70	0.05
Symptoms	2.47	1.86-3.28	<0.01	1.18	0.56-2.51	0.67
CAD	1.09	0.77-1.54	0.624	2.44	1.21-4.89	0.01
HTN	1.28	0.97-1.68	0.08	1.67	0.87-3.22	0.12
COPD	1.34	0.84-2.12	0.22	0.63	0.15-2.70	0.53
Renal Failure	1.45	0.78-2.69	0.24	5.36	2.22-13.0	<0.01
Diabetes	1.09	0.77-1.54	0.63	1.12	0.50-2.48	0.78
Smoking	1.89	1.17-3.03	<0.01	0.73	0.17-3.17	0.67

Table 6

Characteristic	Odds Ratio	95% CI	p-value
Surgical specialty			
Neurosurgery	0.581	0.32-1.06	0.075
General	0.599	0.324-1.11	0.101
Vascular	1.00		
University Hospital	1.59	0.90-2.80	0.107
Patient			
Age 65-74	2.54	1.322-4.88	0.005
Age 75 and older	2.95	1.46-5.98	0.003
Female	1.42	0.889-2.28	0.141
Symptoms	1.99	1.22-3.22	0.005
CAD	3.32	2.06-5.34	<0.001
HTN	1.06	0.664-1.69	0.815
COPD	1.33	0.620-2.85	0.465
Renal failure	2.22	1.015-5.33	0.046
Diabetes	1.21	0.692-2.11	0.505
Smoking	1.54	0.681-3.50	0.299

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Discussion (THESIS):

The objective of this study was to audit the carotid endarterectomy experience in the province of Quebec. We performed the following statistical analysis:

(1) The rate of carotid endartectomies in the province of Quebec, and an analysis of any outcomes between 1996-1999.

(2) An analysis of surgical outcomes between symptomatic and asymptomatic patients

(3) A comparison between the three surgical specialties that most frequently perform CEAs: the general surgeon, the vascular surgeon, and the neurosurgeon

(4) A comparison between teaching and non-teaching hospitals performing carotid endarterectomy.

Rates of CEA in the province of Quebec

An international comparison of published rates of CEA improves the understanding of how different health care systems respond to the same published literature. The two most notable studies were the NASCET and the ACAS, which strongly supported the use of CEA in symptomatic and asymptomatic patients, respectively. In the United States , the number of CEA procedures rose 94% from 1991 to 1996[34] likely from the publication of the two trials. A fourfold increase in rate of CEA since 1991 also occurred in reports from Scotland[35].

In Quebec, the publication of the NASCET resulted in a 38% increase in the rate of CEAs performed. However, the response to the ACAS was more cautious; the rate increased initially by 26% however by 1999 the increase from 1994 had diminished to only 12%. This 12% increase since 1994 is a stark contrast with reported increases of 45% and 74% in New York[36] and Florida[37] respectively.

Is Quebec's tepid response to the dissemination of the clinical trials the appropriate response, or is the province lagging behind other health care systems resulting in a significant disservice to its population?

As previously discussed, both the NASCET and the ACAS demonstrated a significant benefit from CEA if a low rate of peri-operative complications can be maintained (ie. A 30-day mortality rate of 0.6% in the NASCET trial and 0.1% in the ACAS) . However mortality rates at many hospitals in Canada and the United States are substantially higher than the rates reported in these trials[36]. Hsia et al demonstrated a peri-operative mortality of 1.6% in all Medicare beneficiaries in the United States.[38] In Quebec, mortality was 1.0% between 1997 and 1999. Even though the mortality rate is higher than those reported in the NASCET, the large benefit of CEA in patients with severe symptomatic stenosis demonstrated in the NASCET will provide an adequate cushion to absorb the poorer outcomes reported in Quebec. Very few doubt the benefit of CEA in symptomatic carotid stenosis (>70%) despite higher than expected mortality rates however, as previously described, much controversy exists regarding the management of asymptomatic patients. Much of the recent changes in CEA rates are likely due to changing opinions regarding the management of asymptomatic stenosis. Peri-operative stroke rates reported in published series are frequently higher than the 2.3% rate reported in the ACAS. Community-based or multi-centred studies have demonstrated much higher rates for peri-operative stroke and mortality after CEA for asymptomatic stenosis, ranging from 3.2 to 6.9%.[39-45] Therefore, as demonstrated by both trials, in order for the Quebec population to benefit from the CEA peri-operative stroke rates must be monitored and kept below 6% for symptomatic patients and <3% for asymptomatic patients. Quebec's stroke peri-operative stroke rate between 1996-1999 was 5.5%. This justifies the use of CEA in symptomatic patients however not in asymptomatic patients. Despite the difficulty in differentiating symptomatics and asymptomatics using a governemental database (to be discussed later) it is likely than the stroke rate amongst asymptomatics would be higher than 3%.

Quebec's unenthusiastic response to the ACAS trial may be appropriate given the marginal benefit in asymptomatic patients and the fact that there is very little leeway in surgical performance standards. There is a strong consensus amongst the neurologist of Canada against both endarterectomy and routine screening for asymptomatic carotid artery stenosis.[16] Furtherly, Henry JM Barnett, a neurologist from McMaster University in Hamilton, Canada, has been extremely vocal in his criticism of the ACAS trial and has frequently published his recommendation that CEA not be routinely performed in asymptomatic patients.[18,23,46-48] The consensus in Canada led by Barnett may be responsible for the relatively low rate reported in Ontario[36] and the low and declining rate in Quebec. This "Barnett Syndrome" is a likely explanation for the strong variation in rates between Quebec and the United States. Chatuvedi et al [49] performed a survey comparing the attitudes of 270 American neurologists from either Florida or Indiana with 180 neurologists from Ontario or Quebec. Both Florida (65%) and Indiana neurologists (35%) were significantly more likely than the Canadian neurologists (11%) to refer asymptomatic patients for surgery. American neurologists cited medicolegal concerns as a reason for referral (27%) compared to Canadian neurologists (3%). This confirms the power of the "Barnett Syndrome" over the Canadian attitudes towards asymptomatic stenosis. It also provides another possible explanation for the higher rate in the United States when compared to Quebec: fear of legal action from asymptomatic patients who suffer a cerobrovascular accident. The Quebec medico-legal system is significantly less profitable for disgruntled patients creating a relatively more comfortable and secure environment. This may allow neurologists and other referring physicians to be more selective in their referral pattern. Therefore, the wide geographic variation in rates of CEA reflect the different practice policies between Canada and the United States. A decision to perform CEA, especially in asymptomatic patients should be based on morbidity rates and should not be performed in centres with high peri-operative stroke rates.

Between 1996-1999, Quebec has seen no change in the mean age; however there has been an increase in co-morbid conditions like CAD, hypertension, and COPD. The proportion of females was reduced by 5%. The ACAS study was limited to patients younger than 79 years of age; therefore little prospective data exists with regards to the benefits of CEA in the older patients with asymptomatic carotid stenosis. Similarly, data from the ACAS did not demonstrate any benefit for asymptomatic females. In a multicenter review of asymptomatic patients, post operative stroke or death was considerably higher than those older than 75 years of age when compared to their younger counterparts (7.8% vs 1.8%) and the stroke rate for females was over three times higher than males[50]. Despite this, between 1992 and 1996, the Florida rate of CEA in patients aged 80 years and older rose 82%, in step with the younger patients. In addition, the percentage increase in surgical procedures in women kept pace with the increase in men.[37]. All these increases occurred in subgroups that had no solid data to support the benefit of carotid endarterectomy. In Florida's 1996 data, 17.8% of patients were >80 years of age and 41.9% were female. During the same year in Quebec 5.8% were older than 80 years and only 36.6% were female. Using the US Medicare database data, in patients over 75 years of age, the share of surgery steadily increased from 34.5% in 1985 to 43.7 in 1996 and there was a slight increase in the proportion of females (43.8% female in 1996). [38] In Quebec, the proportion of Females and older patients is significantly less than the American rates. Therefore, the low rate in CEA in Quebec may be due to the stricter adherence to the proven indications for CEA in asymptomatic patients. It seems our American counterparts have extrapolated the benefits of CEA in asymptomatics to include females and older patients however, this may not be warranted and may represent an overly enthusiastic response to clinical trials.

Based on this study, performance standards in Quebec do not comply with the proficiency required from the clinical trials and therefore may not be beneficial in asymptomatic patients in our present health care system.

The impact of surgical specialties on outcome following CEA

An exhaustive MEDLINE search revealed no publications comparing the results of different surgical specialties performing CEA. In the ACAS trial 84% of enrolled surgeons were vascular surgeons and the rest were neurosurgeons[17], however no data was published comparing these two specialties. In Quebec, 47% of CEA were performed by Vascular surgeons, 31% by general surgeons, and 22% performed by Neurosurgeons. Over the three years, there was a 16% reduction in proportion of CEAs performed by vascular surgeons despite a 50% increase from neurosurgeons. Neurosurgeons operated on significantly more males, however there was no difference in age. Neurosurgeons had a significantly higher stroke rate (7.9%) when compared to vascular surgeons (5.0%) and general surgeons (4.6%). Being operated on by a neurosurgeon remained an independent risk factor for peri-operative stroke even after controlling for co-morbid conditions (OR:1.73, $p=0.002$). Vascular surgeons had a higher post-operative MI rate (2.5%) when compared to neurosurgeons (1.6%, $p=0.013$), however this increased risk did not remain significant following multivariate analysis. Length of stay was also considerably higher amongst neurosurgeons even after adjusting for their higher rates of post-operative stroke. Finally, the death rate was higher amongst vascular surgeons, however being operated on by a vascular surgeon was not an independent risk factor with multivariate analysis.

Firstly, the higher proportion on Quebec's carotids being performed by neurosurgeons is likely a reflection of the changing consensus of neurologists regarding CEA in Quebec: the Barnett Syndrome. The neurologists frequently act as the "gatekeeper" to this operation.[51] and consequently it is their referral patterns that frequently determine rates of carotid endarterectomy. While CEA for asymptomatic patients became out of favour amongst Canadian neurologists, they maintained their referral of symptomatics (including acute strokes) to the neurosurgeons while curtailing their referral of asymptomatics to the vascular surgeons. Neurosurgeons tend to have more symptomatic patients referred to them because the patient illness includes neurological deficits and neurologists frequently appreciate a surgical opinion regarding the best management for the patient. Therefore as the proportion of symptomatics rose, the proportion of cases done by the neurosurgeons increased with a concomitant drop in the proportion performed by vascular surgeons.

After controlling for multiple variables, the post-operative relative risk of stroke remained significantly higher for the neurosurgery cohort. Possible explanations include: (1) The inability to adequately control for the higher proportion of symptomatics amongst neurosurgeons or (2) technical differences and use of the vascular lab per-operatively between specialties. (3) Different sensitivities between specialties in diagnosing post-operative stroke.

Pre-operative symptoms are an accepted risk factor for post-operative stroke. Using the MED-ECHO database we attempt to identify all patients who have a neurological event as a primary or secondary diagnosis. This identified only 810 (19%) patients. Most prospective and chart review studies which do not rely on administrative data have a significantly larger proportion of symptomatic patients. In a recent audit of 678 Medicare patients in Ohio, 52.5% were symptomatic.[52] At our institution (CHVO) 45/96 (47%) of patients operated on between 1997-1999 were symptomatic however, the database revealed only 14 of the 45 patients (15%). Overall in our database about 19% of the patients were identified as symptomatic, likely an underestimation of the true proportion. Even though we attempt to compensate for the higher stroke rate in symptomatic patients using multivariate analysis, this may be incomplete. A higher than expected stroke rate amongst neurosurgeons may be partially due to a possibly higher proportion of symptomatic patients in this cohort.

Secondly, vascular surgeons may have a distinct technical advantage over neurosurgeons because of the larger volume of vascular surgery that they perform. Neurosurgeons have to develop not only skills to perform an endarterectomy but many other types of operations and therefore they may have less time to gain expertise in vascular procedures. It has been shown in numerous studies that surgeons with high volumes have better outcomes for ruptured aneurysms and CEAs[53-56]. In addition, surgeons with a greater proportion of their practice in vascular surgery had better outcomes with ruptured aortic aneurysms. Vascular surgeons not only perform endarterectomies on the carotid but also on arteries throughout the body while neurosurgeons perform endarterectomies solely on extracranial circulation. The resultant higher number of endarterectomies performed may provide the necessary experience to maintain a low stroke rate.

The vascular surgeons closer relationship to the vascular lab may result in the increased use of the intra-op Doppler following carotid reconstruction. This has been shown to reduce peri-operative stroke rate. Even though we cannot quantify this with our database, it seems likely that the vascular surgeons comfort with the use of the Doppler may reduce incidence of post-op stroke.

This data may have important implications, however, it should not be used to deny any surgeons with excellent surgical outcome the opportunity to perform this vascular procedure.

Finally, the diagnosis of post-operative stroke may vary between specialties. In a review of 51 studies of carotid endarterectomy for asymptomatic stenosis, stroke rates were highest in studies in which the patient was assessed by a neurologist after surgery (7.7%).[27] Similarly neurosurgeons may be more sensitive in their post-operative surgical assessment and therefore may report a higher stroke rate when compared to vascular surgeons.

We based our classification on the category that the surgeons are usually coded with. This may classify older general surgeons who received vascular surgery training as general surgeons because the specialty of vascular surgery was not recognized by the Royal College of Surgeons of Canada until 1981. Even though these older surgeons have a predominantly vascular practice, they are still classified as general surgeons. Interestingly, their outcomes are very much the same as the vascular surgery cohort. Therefore, there may have been some misclassification between the general surgeon and vascular surgeon cohorts. However, whether they are separate or combined, their outcomes are significantly different from the neurosurgeons.

Comparison Between Teaching and Non Teaching Centres

Our final goal was to assess whether there was any difference in outcomes between teaching and non-teaching centres. A notable element of most teaching institutions is surgeon directed institutional peer review. This process, frequently referred to as Morbidity or Mortality Rounds, is a forum where physicians provide constructive feedback on patients with poor surgical outcomes. Olcott et al demonstrated that the stroke rate was reduced from 3.8% to 0%, the mortality reduced from 2.8% to 0% and the length of stay from 4.7 days to 2.6 days[57]. This was a prospective study where the goal was to improve outcome following active peer reviews. Kresowik provided 30 hospitals with individual outcome data and also instituted a structures peer review process in an attempt to reduce morbidity following CEAs[30]. Combined stroke or mortality rates were reduced over two years from 7.8% to 4.0%, and the use of intraoperative duplex increased from 20% to 46%. They emphasised the importance of confidential feedback and a standardized outcome assessment forum in order to reduce complication rates.

In Quebec, there seems to be no difference between teaching and non-teaching institutions in stroke or death rate following CEA. The myocardial infarction rate is higher amongst the teaching institutions with univariate analysis, however this difference is not significant after controlling for co-morbid conditions. This questions the quality of peer review in Quebec universities. Our study remains the only published query for outcomes following CEA in Quebec. Outcome data from government databases has never been provided to the surgeons of Quebec, unless individual surgeons organize a personal log of their cases. However, even this self-audit is notoriously biased and unreliable[58]. Chaturvedi et al demonstrated that only 56% of teaching centres questioned were able to provide morbidity and mortality rates for CEAs performed at their institution[32] . He also reported that retrospective analysis accounted for 62% of those institutions who specified a monitoring technique.

Independent and unbiased audit should be emphasised for CEAs in order to improve outcome. This is especially important in universities, which must strive for excellence and set a standard for community centres. This can be accomplished by performing regular morbidity and mortality rounds as well as actively obtaining results from unbiased databases.

Interestingly, Universities have been largely responsible for the reduction in rate between 1996 and 1999. This may be due to predominance of neurologists at teaching institutions. Again, the "Barnett Syndrome" may be responsible for the reduction in the proportion of cases done at universities.

Our data prohibits us from comparing high volume with low volume centres. Over the last few years, there have been numerous hospital closures and mergers. Consequently, the codes of institutions have changed: separate hospitals are now considered as one, despite their geographical separation.

Validity of Database and Difficulties With Interpretation

A population based outcomes study is littered with difficulties in the interpretation of results. Frequently they are relied on to gain an understanding of the effectiveness of therapies by using an extremely large sample population. Based on these studies many authors make strong recommendations; for example, many show improved patient outcomes when treatment occurs in high volume centres or by high volume surgeons. Hospitals in Quebec have recently regionalized health care for certain procedures like transplantation or cardiac surgery. However, are these retrospective population based studies sound enough to draw firm conclusions that should influence health policy? Following the analysis of the CEA database, should this procedure be performed only by vascular surgeons and on symptomatic patients?

How accurate is our database?

The carotid endarterectomy database is based on the medical discharge summary sheet for each patient admission. It is clear to most clinicians that the accuracy and completeness of this form is extremely suspect. A hospital-level review of data used in an Ontario Pancreatic study found that coding for major surgical procedures and patient operative mortality was extremely accurate[59]. But the coding of minor post-operative complications or secondary diagnoses is suspect[60]. Therefore, in the CEA database, the rates of the procedure and the mortality following the CEA are likely very accurate, however, co-morbidities, the assessment of pre-op symptoms and post-operative complications must be viewed critically.

In an attempt to assess, whether pre-op symptoms were adequately controlled for we audited our institutions experience and found a major discrepancy between the database and our chart review, highlighting a major fault in our data. However, some co morbidity rates (like CAD, COPD, Renal failure) seem to correspond well to prospective studies involving the carotid endartectomy. However, the difference in co-morbidities between specialties indicates a very strong reporting bias and may confound our comparison between specialties. Therefore, the major difficulty lies in the controlling of potential confounders and the reporting differences between different specialties and different hospital centres.

Conclusion

The CEA database has highlighted important results, some of which are solid and valid and some that are weaker and open to wide interpretation.

The firm conclusions that we can draw are:

(1) The rate of the CEA is significantly less than our American counterparts and continues to decline.

(2) The vast majority of CEAs are performed by vascular surgeons and in a university centre.

(3) Our stroke and death rate supports the use of the CEA in symptomatic patients however does not prove a benefit to asymptomatic patients

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