Urgency of Carotid Endarterectomy for Secondary Stroke Prevention
Results From the Registry of the Canadian Stroke Network

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Background and Purpose — The benefit of carotid endarterectomy for preventing recurrent stroke is maximal when surgery is performed within 2 weeks after ischemic stroke or transient ischemic attack; the benefit is reduced when surgery is delayed >2 weeks and essentially lost if delayed >3 months. Guidelines recommend endarterectomy within 2 weeks poststroke/transient ischemic attack for patients with symptomatic carotid stenosis. This study examined time to endarterectomy at designated stroke centers as a measure of evidence-based best practices for stroke prevention.

Methods — From the Registry of the Canadian Stroke Network, we identified all consecutive patients presenting with acute ischemic stroke or transient ischemic attack at 12 provincial stroke centers (Ontario, Canada, 2003 to 2006) and selected those with unilateral symptomatic carotid stenosis of moderate (50% to 69%) or severe (70% to 99%) degree. Using linkages to administrative databases, we identified patients who underwent carotid endarterectomy within 6 months after the symptomatic event and calculated the time intervals between the index event and surgery. We compared the timing of surgery according to age, sex, degree of stenosis, index event, geographic region, and year. Logistic regression assessed variables associated with early surgery.

Results — One hundred five patients underwent endarterectomy for unilateral symptomatic carotid stenosis (50% to 99%) within 6 months of the index event. The median time from index event to surgery was 30 days (interquartile range, 10 to 81). Only one third (38 of 105) received endarterectomy within the recommended 2-week target timeframe, and in one fourth (26 of 105), surgery was delayed >3 months. Surgery within 2 weeks was more likely if the index event was a transient ischemic attack rather than a stroke. Access to early endarterectomy varied markedly between hospitals across the province and improved over time from 2003 to 2006.

Conclusions — In this hospital-based cohort, the majority of patients undergoing carotid endarterectomy after a transient ischemic attack or stroke had surgery delayed well beyond the period of maximum effectiveness. To enhance secondary stroke prevention, greater efforts are needed to minimize delays to diagnosis and surgical treatment for patients with symptomatic carotid stenosis. (Stroke. 2009;40:2776-2782.)

Key Words: carotid endarterectomy ■ stroke prevention ■ symptomatic carotid stenosis ■ wait times

Symptomatic extracranial carotid artery stenosis (50% to 99%) poses a high immediate and short-term risk of stroke. Without surgery, the 90-day stroke risk may be as high as 20%1 to 30%.2 Carotid endarterectomy has proven highly effective for reducing this risk.3 However, only recently has it become appreciated that the benefit of endarterectomy is very dependent on the timing of surgery in relation to the presenting transient ischemic attack (TIA) or stroke event. A pooled analysis of the North American and European endarterectomy trials found that for patients with 50% to 99% carotid stenosis, surgery was most effective when performed within 2 weeks of the index ischemic event (with a number needed to treat of 5 to prevent one stroke over 5 years), and the benefit declined quickly over time (number needed to treat of 125 if surgery was delayed >3 months).4 This time-dependent benefit was especially pronounced for patients with moderate (50% to 69%) carotid stenosis, in which endarterectomy was beneficial within the first 2 weeks, but the benefit was lost (and there was net harm) when surgery was delayed >3 months4 (Table 1). Therefore, timely
surgery is even more important for patients with moderate stenosis than for patients with severe stenosis. Additionally, the benefit of carotid endarterectomy for women is largely realized within the first 2 weeks, with women deriving less benefit with later surgery compared with men, possibly due to sex differences in carotid plaque pathology.5,6 The safety of performing carotid endarterectomy early has been demonstrated in several recent studies with perioperative morbidity and mortality rates comparable to that for delayed surgery in otherwise stable patients.7–11 These data have changed practice guidelines for carotid endarterectomy.12,13,13a According to the American Academy of Neurology, “For patients with severe stenosis and a recent TIA or nondisabling stroke, [carotid endarterectomy] should be performed without delay, preferably within 2 weeks.”12 Similarly, the National Stroke Association recommends that “surgery should be performed as soon as the patient is fit for the procedure, preferably within 2 weeks of TIA (cerebral or retinal).”14 It is unclear whether these guidelines, published in 2005 and 2006, are being translated into clinical practice.

The objectives of this study were: (1) to evaluate how quickly carotid endarterectomy is being performed at designated stroke centers in Ontario; (2) to explore what factors influence timely access to carotid endarterectomy; and (3) to compare the timing of endarterectomy before and after the publication of updated clinical practice guidelines.

Methods

Description of the Registry

This study used data from the Registry of the Canadian Stroke Network (Phase 3), an ongoing prospective database of all consecutive acute cerebrovascular events at designated stroke centers.13 Participating institutions are large-volume tertiary care centers with specialized stroke care resources and expertise. Eligible patients are identified by trained research coordinators at each site who review daily emergency department records and hospital admission logs. Standardized data collection forms with clearly defined fields are used to record patient demographics, most responsible diagnosis, presenting signs and symptoms, side of symptoms, stroke severity, Oxfordshire Community Stroke Project classification of stroke types, stroke severity as measured by the Canadian Neurological Scale,17 medical history and risk factors, medications, diagnostic tests, treatments, and discharge disposition. Specialized software is used for data entry; this software checks the ranges and internal consistency of data to increase data quality. The database captures all brain imaging and vascular imaging performed in the emergency department or in the hospital for admitted patients (including carotid Doppler ultrasound, CT angiography, MR angiography, or digital subtraction angiography). The degree of carotid stenosis is recorded for the right and left side and classified as: trace (<30%), mild (30% to 49%), moderate (50% to 69%), severe (70% to 99%), or occluded (100%).

Description of the Cohort

For this study, we retrospectively assembled a cohort of patients from the registry who had unilateral symptomatic carotid stenosis (50% to 99%) and underwent carotid endarterectomy within 6 months of their presenting symptomatic event. We first identified all patients presenting to the emergency department with an acute ischemic stroke or TIA between July 2003 and September 2006 at 12 designated stroke centers in Ontario, Canada’s largest province. These sites include all 9 of the Ontario regional (primary) stroke centers plus 3 district stroke centers; these hospitals represent different geographic regions of the province and have been designated by the provincial government as part of the Ontario Stroke System of regionalized stroke care. We excluded patients presenting with transient monocular blindness, posterior circulation events, intracerebral hemorrhage, or an in-hospital stroke/TIA event. We only included patients who had carotid imaging performed as part of the index hospital presentation and documenting moderate (50% to 69%) or severe (70% to 99%) stenosis of the symptomatic carotid artery. We excluded patients who did not receive carotid imaging before discharge and patients with mild stenosis (<50%) or complete occlusion of the symptomatic carotid artery. To ensure that we included only patients with symptomatic (and not asymptomatic) carotid stenosis, we restricted the cohort to only those patients whose symptomatic stenosis was either contralateral to the presenting neurological symptoms or ipsilateral to an area of acute cerebral ischemia detected on neuroimaging. Furthermore, we excluded patients with moderate or severe stenosis of the contralateral (asymptomatic) carotid artery to avoid inadvertently capturing any patients who may have been operated on for asymptomatic stenosis. Using linkages to the Canadian Institute for Health Information administrative database of all procedures performed at all acute care Ontario

### Table 1. Benefit of Carotid Endarterectomy in Relation to the Timing of Surgery After a TIA or Ischemic Stroke*

<table>
<thead>
<tr>
<th>Timing of Surgery After TIA/Stroke</th>
<th>Absolute Reduction in the 5-Year Risk of Ipsilateral Carotid Ischemic Stroke (and any perioperative stroke or death within 30 days)</th>
<th>No. Needed to Treat (NNT) to Prevent 1 Stroke in 5 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe carotid stenosis (70–99%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery within 2 weeks</td>
<td>30%</td>
<td>3</td>
</tr>
<tr>
<td>Surgery delayed 2–4 weeks</td>
<td>18%</td>
<td>6</td>
</tr>
<tr>
<td>Surgery delayed 1–3 months</td>
<td>11%</td>
<td>9</td>
</tr>
<tr>
<td>Surgery delayed &gt;3 months</td>
<td>9%</td>
<td>11</td>
</tr>
<tr>
<td>Moderate carotid stenosis (50–69%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery within 2 weeks</td>
<td>15%</td>
<td>7</td>
</tr>
<tr>
<td>Surgery delayed 2–4 weeks</td>
<td>3%</td>
<td>33</td>
</tr>
<tr>
<td>Surgery delayed 1–3 months</td>
<td>4%</td>
<td>25</td>
</tr>
<tr>
<td>Surgery delayed &gt;3 months</td>
<td>−3% (net harm)</td>
<td>†</td>
</tr>
</tbody>
</table>


†No. needed to harm = 33; ie, for every 33 patients treated, zero strokes will be prevented and one additional stroke will be caused as a result of the treatment.
hospitals, we selected all patients who underwent carotid endarterectomy within 6 months after the index event onset date (International Classification of Diseases, 10th Revision CCI procedure code=1JE57). Database linkage was done using unique encrypted patient identifiers (ie, a scrambled version of the provincial health insurance card number, which is unique to each citizen).

Analysis
We calculated the time intervals between the index event and carotid endarterectomy for each patient. We compared the median time to endarterectomy for patients with moderate versus severe stenosis and for other subgroups using the Kruskal-Wallis test. Comparison of median times across the 12 hospitals was done using the Kruskal-Wallis test, and a median regression was performed to assess for temporal trends in the median times between 2003 and 2006. Multivariable logistic regression was performed to assess the association between early (<2 weeks) surgery and the following variables that were chosen a priori as potentially relevant factors based on the literature4: age, sex, degree of carotid stenosis (moderate versus severe), and qualifying event (TIA versus stroke).

Results
Of 10 213 ischemic stroke and TIA events in our registry meeting our inclusion criteria, 6270 (61.4%) received carotid imaging in hospital, and of those, 1011 (16.1%) were found to have a presumed symptomatic carotid stenosis of 50% to 99%. Among those patients, 177 (17.5%) underwent endarterectomy within 6 months of the index event. After excluding patients with bilateral carotid stenosis, there were 105 patients with unilateral stenosis who underwent endarterectomy (80% with severe stenosis, 20% with moderate stenosis), and this group represents the final cohort for all subsequent analyses. Patient characteristics are shown in Table 2. The mean age was 70.1 ± 0.9 years and three fourths were men.

Of the cohort that underwent carotid endarterectomy within 6 months, the median time from index event to surgery was 30 days (interquartile range, 10 to 81). Overall, approximately one third (38 of 105) underwent surgery within 2 weeks, half (53 of 105) received surgery within 1 month, and one fourth (26 of 105) had surgery >3 months after the presenting event.

Table 2. Characteristics of Patients Who Underwent Carotid Endarterectomy for Symptomatic Stenosis in the Registry of the Canadian Stroke Network, Ontario Sites, 2003 to 2006 (n=105)

<table>
<thead>
<tr>
<th>Demographics</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Age, mean (SD)</td>
<td>70.1 (0.9)</td>
<td></td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>78 (74.3%)</td>
<td></td>
</tr>
<tr>
<td>Index event</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ischemic stroke, n (%)</td>
<td>72 (68.6%)</td>
<td></td>
</tr>
<tr>
<td>TIA, n (%)</td>
<td>33 (31.4%)</td>
<td></td>
</tr>
<tr>
<td>Stroke severity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admission Canadian Neurological Scale score, median (interquartile range)</td>
<td>10.5 (9–11.5)</td>
<td></td>
</tr>
<tr>
<td>Presenting symptoms/signs</td>
<td></td>
<td></td>
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<tr>
<td>Unilateral weakness, n (%)</td>
<td>88 (83.8%)</td>
<td></td>
</tr>
<tr>
<td>Unilateral sensory symptoms, n (%)</td>
<td>46 (43.8%)</td>
<td></td>
</tr>
<tr>
<td>Aphasia, n (%)</td>
<td>37 (35.2%)</td>
<td></td>
</tr>
<tr>
<td>Visual field defect, n (%)</td>
<td>8 (7.6%)</td>
<td></td>
</tr>
<tr>
<td>Dysarthria, n (%)</td>
<td>38 (36.2%)</td>
<td></td>
</tr>
<tr>
<td>History and comorbidities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior TIA, n (%)</td>
<td>31 (29.5%)</td>
<td></td>
</tr>
<tr>
<td>Prior stroke</td>
<td>10 (9.5%)</td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>72 (68.6%)</td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>21 (20%)</td>
<td></td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>45 (42.9%)</td>
<td></td>
</tr>
<tr>
<td>Past smoking</td>
<td>62 (59%)</td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>29 (27.6%)</td>
<td></td>
</tr>
<tr>
<td>Angina</td>
<td>17 (16.2%)</td>
<td></td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>16 (15.2%)</td>
<td></td>
</tr>
<tr>
<td>Coronary bypass surgery or stenting</td>
<td>13 (12.4%)</td>
<td></td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>7 (6.7%)</td>
<td></td>
</tr>
<tr>
<td>Carotid imaging performed at initial hospital presentation*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carotid Doppler ultrasound</td>
<td>75 (71.4%)</td>
<td></td>
</tr>
<tr>
<td>MR angiography</td>
<td>29 (27.6%)</td>
<td></td>
</tr>
<tr>
<td>CT angiography</td>
<td>27 (25.7%)</td>
<td></td>
</tr>
<tr>
<td>Admitted to the hospital from emergency department</td>
<td>82 (78.1%)</td>
<td></td>
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</tbody>
</table>

*Patients could have more than one test.

Analysis of the multivariable logistic regression model indicated that early surgery (within 2 weeks) was significantly more likely to occur if the index event was a TIA rather than a completed stroke (OR, 2.6; 95% CI, 1.1 to 6.1); age, sex, and degree of stenosis were not significant predictors of early surgery.

Timing of endarterectomy varied widely among institutions across the province with median times to surgery for each hospital ranging from 2 days to 129 days (Figure 1).

Compared with our cohort of patients who underwent carotid endarterectomy within 6 months, the 834 (82.5%) who did not undergo surgery within 6 months were significantly older, had more severe strokes and more medical comorbidity (previous stroke, angina, atrial fibrillation, pulmonary edema, dementia), fewer were functionally independent before admission, and more were declared “palliative” in the hospital (P < 0.004 for each variable); the carotid stenosis was severe in one third and moderate in two thirds. The 6-month mortality rate was 3.4% among the endarterectomy cohort compared with 12.9% for the nonsurgical group (P = 0.0003).

Discussion
This study reveals that for most patients in need of carotid endarterectomy, surgery is not being performed as urgently as...
current guidelines recommend. Only a minority of patients who underwent endarterectomy in this hospital-based Ontario cohort did so within the recommended 2-week target time frame after a cerebral ischemic event, and half had surgery delayed >1 month. One in 4 patients underwent endarterectomy 3 months poststroke/TIA, at which time the major benefit of endarterectomy has already been lost.

Patients with TIA (who are arguably the best candidates for early stroke prevention surgery) were significantly more likely than patients with a completed stroke to undergo endarterectomy within 2 weeks, yet half of them still had their surgery delayed >2 weeks. We observed an encouraging trend toward more timely access to carotid endarterectomy over time between 2003 and 2006. This improvement may reflect a true practice change after the important publication by Rothwell and colleagues of the carotid endarterectomy pooled analysis in 2004 followed by new carotid endarterectomy guidelines in 2005 and 2006. The improvement may also reflect recent efforts of the Ontario Stroke System, a major provincial investment in organized stroke care over

Table 3. Timing of Carotid Endarterectomy After Stroke/TIA for Patients With Symptomatic Carotid Stenosis in the Registry of the Canadian Stroke Network, Ontario Sites, 2003 to 2006

<table>
<thead>
<tr>
<th></th>
<th>Overall cohort</th>
<th>Women (n=27)</th>
<th>Men (n=78)</th>
<th>OR (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median Time to Surgery (interquartile range), Days</td>
<td>30 (10–81)</td>
<td>48 (12–123)</td>
<td>24 (9–76)</td>
<td>1.1 (0.4–2.6)</td>
<td>0.138</td>
</tr>
<tr>
<td>Percentage of Patients Undergoing Endarterectomy Within Specified Time Periods After the Index Stroke or TIA</td>
<td>38/105 (36.2%)</td>
<td>10/27 (37%)</td>
<td>28/78 (35.9%)</td>
<td>0.915</td>
<td></td>
</tr>
<tr>
<td></td>
<td>53/105 (50.5%)</td>
<td>11/27 (40.7%)</td>
<td>42/78 (53.8%)</td>
<td>0.243</td>
<td></td>
</tr>
<tr>
<td></td>
<td>79/105 (75.2%)</td>
<td>17/27 (63%)</td>
<td>62/78 (79.5%)</td>
<td>0.091</td>
<td></td>
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<tr>
<td></td>
<td>0.138</td>
<td>0.915</td>
<td>0.243</td>
<td>0.091</td>
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</tbody>
</table>

Age >75 years (n=33) 21 (9–42) 13/33 (39.4%) 25/72 (34.7%) 1.2 (0.5–2.9) 0.122

Age ≤75 years (n=72) 46 (10.5–97) 25/72 (34.7%) 32/72 (44.4%) 2.6 (1.1–6.0) 0.003

OR (95% CI) 1.2 (0.5–2.6) 2.2 (0.9–5.1) 2.3 (0.8–6.8) 0.129

P value 0.138 0.915 0.243 0.091

TIA (n=33) 14 (5–43) 17/33 (51.5%) 21/33 (63.6%) 28/33 (84.5%) 0.003

Ischemic stroke (n=72) 46 (12–101) 25/72 (34.7%) 32/72 (44.4%) 2.6 (1.1–6.3) 0.027

OR (95% CI) 2.6 (1.1–6.0) 2.6 (1.1–6.3) 2.3 (0.8–6.8) 0.129

P value 0.122 0.644 0.070 0.129

Moderate carotid stenosis (n=21) 42 (10–94) 9/21 (42.9%) 10/21 (47.6%) 14/21 (66.6%) 0.920

Severe carotid stenosis (n=84) 27.5 (10–77.5) 29/84 (34.5%) 43/84 (51.2%) 65/84 (77.4%) 0.090

OR (95% CI) 1.4 (0.5–3.8) 0.9 (0.3–2.3) 0.6 (0.2–1.7) 0.312

P value 0.312 0.478 0.050 0.129

Gender

<table>
<thead>
<tr>
<th>Sample Size</th>
<th>Median Time to Surgery (interquartile range), Days</th>
<th>Percentage of Patients Undergoing Endarterectomy Within Specified Time Periods After the Index Stroke or TIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30 (10–81)</td>
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</tr>
<tr>
<td>2</td>
<td>48 (12–123)</td>
<td>10/27 (37%) 11/27 (40.7%) 17/27 (63%)</td>
</tr>
<tr>
<td>3</td>
<td>24 (9–76)</td>
<td>28/78 (35.9%) 42/78 (53.8%) 62/78 (79.5%)</td>
</tr>
<tr>
<td>4</td>
<td>1.1 (0.4–2.6)</td>
<td>0.915 0.243 0.091</td>
</tr>
<tr>
<td>5</td>
<td>0.138</td>
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</tr>
<tr>
<td>6</td>
<td>25/72 (34.7%) 32/72 (44.4%) 51/72 (70.8%)</td>
<td>1.2 (0.5–2.9) 2.2 (0.9–5.1) 2.3 (0.8–6.8)</td>
</tr>
<tr>
<td>7</td>
<td>0.122</td>
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<tr>
<td>9</td>
<td>0.003</td>
<td>0.029 0.027 0.129</td>
</tr>
<tr>
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<td>0.129 0.644 0.070 0.129</td>
</tr>
</tbody>
</table>

Figure 1. Regional variations in stroke onset-to-endarterectomy times across 12 stroke centers in Ontario, 2003 to 2006. Error bars represent 95% CIs.
by guest on October 23, 2017 http://stroke.ahajournals.org/ Downloaded from

of recurrent events while awaiting endarterectomy. 19 Al-

severe symptomatic carotid stenosis reported a 10% early risk

was 12% at 4 weeks.10 A prospective study of patients with

weeks, the risk of recurrent stroke in those awaiting surgery

28% of patients underwent carotid endarterectomy within 4

Similarly, in an Austrian retrospective study in which only

Oxfordshire population-based study in which the median

prevention because delays to endarterectomy are associated

the past few years that has already proven beneficial in other

areas of the stroke care continuum.18

In other countries, published carotid endarterectomy wait
times have been considerably longer than those observed in

our cohort.2,10 It is notable that our study focused only on

patients attending designated stroke centers where rapid

access to stroke care is expected to be greater than that

available at community hospitals. Our results may, therefore,

underestimate the problem of timely access to carotid endar-
terectomy for patients who initially present to smaller hospi-
tals. However, even among the designated stroke centers

included in this study, there were striking variations between

hospitals in access to timely endarterectomy, suggesting the

need for provincial standardization and monitoring of this

process of care issue. The hospitals in our study that per-

formed the most endarterectomies tended to have shorter wait

times compared with hospitals with low endarterectomy

volumes.

The timing of carotid endarterectomy for symptomatic

carotid disease is a key benchmark for secondary stroke

prevention because delays to endarterectomy are associated

with an increased risk of recurrent stroke. For example, in an

Oxfordshire population-based study in which the median

endarterectomy wait time was 100 days (interquartile range,

59 to 137) and only 6% of patients underwent surgery within

2 weeks (43% underwent surgery within 3 months), one in 3

patients had a recurrent stroke while awaiting surgery.2

Similarly, in an Austrian retrospective study in which only

28% of patients underwent carotid endarterectomy within 4

weeks, the risk of recurrent stroke in those awaiting surgery

was 12% at 4 weeks.10 A prospective study of patients with

severe symptomatic carotid stenosis reported a 10% early risk

of recurrent events while awaiting endarterectomy.19 Al-

though our study was not designed to assess stroke risk in

those awaiting carotid endarterectomy, we can only infer

from this literature that some patients in our registry who

were potential endarterectomy candidates may have had a

recurrent stroke while awaiting surgery.

Potential reasons for delays to carotid endarterectomy

include patient factors (delayed symptom recognition and

presentation to medical attention), physician factors (delayed

diagnosis and referrals), resource availability (rapid access to

vascular imaging), and institutional/system-level factors re-

lating to operating room availability and staffing. In our study,

patient factors were not likely to have been responsible for any

significant delays, because most patients in our cohort pre-

sented to hospital within 24 hours of their clinical event. The

Registry of the Canadian Stroke Network database did not

record the time from clinical presentation to carotid imaging

so we could not calculate the average delays to imaging in

this study. However, because all patients in this study had

vascular imaging as part of their initial hospital presentation,

delays in the identification of carotid stenosis probably did

not play a major role in prolonging the time to surgery in

this study. Our database did not record the time of surgical

referral or consultation, so we could not calculate the actual

surgical wait times, and we did not have data on surgeon

volumes at each hospital. We do acknowledge that in some

cases, there may have been legitimate reasons for delaying

surgery, ie, for patients who were medically or neurologically

unstable. Other potential reasons for delays to endarterectomy

include a shortage of surgeons who perform this procedure in

Ontario and a lack of awareness about the timing of endar-
terectomy among family physicians and internists (who care

for the majority of patients with stroke in Ontario). The

overall rate of carotid endarterectomy within 6 months among

all patients presenting with a presumed acute symptomatic

carotid stenosis (18%) was much lower than expected; we can

only speculate that there may have been a bias against oper-

ating on patients who were older and had more medical

comorbidity, more severe strokes, and moderate rather than

severe carotid stenosis.

Several limitations of this study must be noted. The sample

size is small, although it is comparable to other recent studies

examining this issue. Ontario is Canada’s largest province

and is highly representative of healthcare delivery in Canada.

The results of this study should be relevant to all hospitals

that perform carotid endarterectomy for secondary stroke

prevention. We intentionally restricted our cohort to patients

with unilateral carotid disease to be sure that we only selected

operating on patients who were older and had more medical

comorbidity, more severe strokes, and moderate rather than

severe carotid stenosis.

Another important limitation of the study is that we only

included patients with stroke/TIA who presented to hospital

(and underwent carotid imaging in hospital), so we cannot

comment on access to endarterectomy for the many patients

Figure 2. Comparison of median stroke onset-to-endarterectomy

times (2003 to 2006).
with symptomatic carotid disease who are managed entirely on an outpatient basis before surgery. We excluded patients who were discharged from the hospital without carotid imaging, because our registry did not contain outcome data for these patients; we presume that such patients were subsequently referred for outpatient vascular imaging, but the results of these tests could not be tracked by our registry or provincial administrative databases. We recognize that the exclusion of this outpatient component likely introduces a selection bias in our study. We speculate that for some patients discharged without carotid imaging, the additional wait for outpatient imaging may result in longer delays to surgical referral and endarterectomy; conversely, it is possible that outpatient clinic management at some centers may enable quicker access to surgery. Conclusions drawn from this hospital-based study, therefore, cannot be generalized to the entire population of patients with symptomatic carotid stenosis.

This study has implications for improving adherence to best practice guidelines for stroke prevention. Expediting the diagnosis and treatment of symptomatic carotid disease must become a priority for all hospitals that care for patients with acute stroke and TIA. For patients with acute high-risk TIAs and minor strokes, carotid imaging should be performed ideally within 24 hours, which can be accomplished rapidly and noninvasively in most emergency departments using CT angiography when carotid ultrasound is unavailable; MR angiography is another option when available. An online calculator can be helpful in predicting stroke risk for individual patients with carotid stenosis (www.stroke.ox.ac.uk/). The creation of dedicated, rapid-response outpatient stroke/TIA clinics is one way to fast-track the diagnosis and management of patients with symptomatic carotid disease. For example, a recent study demonstrated the feasibility and effectiveness of urgent, aggressive outpatient management of patients with TIA and minor stroke with an increase in the proportion of patients receiving early carotid endarterectomy (within 30 days) from 12% to 67% and a decrease in 90-day stroke risk from 10% to 2%. In another recent study demonstrating the effectiveness of a dedicated TIA clinic, expedited carotid revascularization was able to be achieved within a median time of 6 days.

In conclusion, stroke prevention surgery with carotid endarterectomy should be performed early after a cerebral ischemic event to be most effective. Clinicians and administrators must be aware that carotid endarterectomy for symptomatic stenosis is a time-sensitive treatment, and hospital protocols should aim to streamline diagnostic imaging for high-risk patients with stroke/TIA and provide urgent operating room availability for suitable candidates. The “onset-to-endarterectomy” time should be monitored as a key performance indicator for stroke prevention. Time of 6 days.23 Wait time for outpatient imaging may result in longer delays to surgical referral and endarterectomy; conversely, it is possible that outpatient clinic management at some centers may enable quicker access to surgery. Conclusions drawn from this hospital-based study, therefore, cannot be generalized to the entire population of patients with symptomatic carotid stenosis.

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None.

References


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