Carotid endarterectomy: a Southern North Island regional consensus statement

Annemarei Ranta, Dilip Naik, Pietro Cariga, Tim Matthews, Gerry McGonigal, Tom Thomson, John Bourke, Stuart Mossman, Tom Thompson, Per Holmberg, Richard Evans, David Abernethy, Yun Lee, Anantha Ramanathan, Danella Favot, Tamlin Clulow, Lindsay Haas

Abstract

Aims The aim of this project was to employ interdepartmental and cross district health board collaboration to reach a regional consensus on the management of patients who may benefit from carotid endarterectomy.

Methods All regional stroke physicians, neurologists, and vascular surgeons met to review relevant literature and local audits and to discuss best management strategies suited to the region.

Results A consensus statement was agreed upon and is presented here along with a summary of the supporting scientific evidence.

Discussion Regional interdisciplinary collaboration proved an effective way to reach a carotid endarterectomy management consensus across a wider geographical area that is served by a single vascular surgery department. This approach could serve as a model for other regional initiatives.

Stroke is the second most common cause of death and a frequent cause of disability worldwide.1 Each year 7600 people suffer a stroke in New Zealand2 and 15–26% of these are preceded by transient ischaemic attacks (TIAs) or minor strokes. The progression to devastating symptoms following TIAs and minor strokes usually occurs within just hours to days3 and it is during this brief time window that evaluation and intervention has its most dramatic impact.

Carotid stenosis is the causative factor in 7–20% of patients with ischaemic stroke.4,5 Carotid endarterectomy (CEA) is an effective preventive measure for some of these patients,6–8 particularly in those presenting with TIAs and minor strokes if performed within 2 weeks of symptom onset.9 Factors that affect the overall benefit of surgical versus medical therapy for both symptomatic and asymptomatic patients are numerous.2,4,6–12 Local audits (unpublished) have confirmed that resources for providing both timely carotid imaging and surgery are limited.

In the setting of a wide body of sometimes conflicting international scientific evidence, which is not always readily applied to local healthcare environments, management strategies across the Southern North Island have been inconsistent at times.

All regional stroke physicians, neurologists and vascular surgeons collaborated to arrive at a regional consensus that aims to maximize treatment benefit within the constraints of our regional resources in accordance with the available scientific
evidence. This paper presents a summary of the available evidence on this topic and reports the final consensus.

Methods
Stroke physicians and neurologists from the lower North Island who refer potential CEA candidates to Wellington Hospital (MidCentral district health board (DHB), Capital and Coast (CC) DHB, Wairarapa DHB, Hutt DHB, and Wanganui DHB) and the Wellington (CCDHB) vascular surgeons attended a consensus meeting on 7 November 2009 with full attendance of all who were invited.

Local DHB audit data and reports from each participating DHB regarding local experience with management of potential CEA patients were presented. In addition, available literature was reviewed and presented both from a surgeon’s and a physician’s perspective. Discussion ensued and a consensus was reached regarding the topics outlined below. This included a standard referral form and process. Several draft versions of this paper were circulated to participants via email with ample opportunity for further discussion and feedback. Expert comments from outside the region were invited as well.

Results
A. LOCAL AUDIT DATA
Audits performed in Wairarapa and MidCentral DHBs highlighted significant hurdles in accessing timely carotid ultrasounds (CUS) and often inappropriate CUS utilisation. In Wairarapa, from March to September 2009, 33 CUS were performed. Only 9% of patients underwent CUS within 24 hours of presentation and only a further 18% within 1 week, whilst 67% of patients waited for more than 2 weeks and up to a year (data unpublished).

In MidCentral DHB, over a 3-month period from January to March 2009, a total of 80 patients were referred for CUS. Of the 26% of patients who were referred without evidence of prior TIA or stroke symptoms (i.e. asymptomatic patients) none had CUS results that affected their subsequent management. Referral reasons included carotid bruits, follow-up scans, pre-coronary artery bypass graft (CABG) scans, and non-specific neurological symptoms such as dizziness.

Of the TIA/stroke “symptomatic” patients who were triaged to be scanned within either 24 hours or 7 days only 56% could be accommodated within that time frame. Of the symptomatic patients four patients (7%) had significant findings on CUS, but three of these were deemed poor surgical candidates after the CUS had been obtained and only one patient was scheduled for surgery, which took place over three months after initial surgical referral.

The Hutt Valley physicians and CCDHB surgeons’ audits highlighted the significant delays in accessing CEA. In the Hutt valley data collection pertained to 158 consecutive strokes (10/08-9/09) and 38 consecutive high risk TIAs (1/09-8/09). Amongst these seven stroke (4.4%) and five TIA patients (13.2%) underwent CEA. The mean time from symptom onset to CEA was 46.5 days (range 2-165).

The surgeons’ audit at CCDHB reviewed all CEAs performed between July 2004 and June 2009. During this time 519 CEAs were performed with a 30-day stroke or death rate of 1.4%. There were 234 asymptomatic and 285 symptomatic patients. The average time from event/abnormal CUS to CEA was 75 (1-180) days. Patient outcome was not independently assessed by a stroke physician or neurologist and patients undergoing CEA concurrently with CABG were excluded from this audit.
B. REVIEW OF NATIONAL AND INTERNATIONAL LITERATURE

1. CEA for symptomatic patients:

The North American Symptomatic Carotid Endarterectomy Trial (NASCET) and the European Carotid Surgery Trial (ECST) are the cornerstone studies supporting CEA to prevent strokes and have been pooled for a combined analysis. The main findings from these studies were that symptomatic patients with a ≥ 70% ipsilateral stenosis benefited significantly from CEA over best medical therapy (BMT) alone, patients with 50-69% ipsilateral stenosis benefited moderately at best, patients with 30-49% stenosis or >99% stenosis did not benefit, and patients with <30% stenosis were harmed by surgery (Table 1).

Subgroup analyses demonstrated that patients with the following criteria benefited the most: male gender, age over 75, status post hemispheric stroke or TIA rather than pure retinal stroke or TIA, patients with non-lacunar infarcts, greater degree of stenosis/irregular plaque surface on imaging, and presence of collaterals and co-existent intracranial atherosclerotic disease. These findings were especially marked in the 50-69% group where female, patients <65 years of age, and those with pure retinal symptoms either did not benefit at all or not enough to warrant surgery.

Timing of surgery is one of the most significant factors identified during further subgroup analysis with maximal benefit being achieved if surgery occurs within 2 weeks of symptom onset and thereafter dropping progressively with no significant benefit from surgery after 3 months for the 70-99% group and no significant benefit after 2 weeks for the 50-69%. This has lead to a change in international guidelines, dictating the need for more urgent intervention in these patients. The evidence to support emergency CEA (<24 hours from symptom onset) is, however, lacking. While such rapid intervention appears logical in high risk patients (e.g. ABCD2 scores >4 or crescendo TIAs) no clear benefit has been demonstrated and surgical risk appears to be higher.

In general, peri-operative risk was highest in patients with organ failure or serious cardiac dysfunction, leukoaraiosis, and contralateral carotid occlusion. Because of the modest benefit for patients with 50-69% stenosis, perioperative risk must be well established to be less than 3% to achieve a net benefit. In contrast, for patients with 70-99% stenosis a perioperative risk of up to 6% is acceptable.

2. CEA for asymptomatic patients:

Three completed Class I studies have evaluated CEA for asymptomatic patients. The Veteran’s Affair study found a non significant trend favouring CEA over BMT in preventing ipsilateral stroke at 4 years (CEA 4.7% vs. BMT 9.4%) and this benefit was offset by a 30-day perioperative death rate of 4.7%. ACAS found a significant benefit in favour of surgery in preventing ipsilateral stroke at 5 years (CEA 5.1% vs. BMT 11%; p=0.0004). When looking at disabling strokes only and taking into consideration the high perioperative risk of disabling strokes the benefit is, however, less convincing (CEA 3.4% vs. BMT 6.0%; p=0.12). Lastly, ACST again found a benefit of surgery over BMT at 5 years (CEA 6.4% vs. BMT 11.8%; p < 0.0001) with results remaining significant if limited to disabling or fatal strokes (p=0.004); however, both contralateral and ipsilateral strokes were included as endpoints, which some experts have criticised.
It is important to note that the overall benefit, while statistically significant, was very small with an absolute risk reduction of stroke of 1% per year at best.

Subgroup analyses showed that there was no benefit of CEA over BMT in patients over the age of 75. Characteristics that may indicate better surgical candidates include male gender, progressing stenosis, and stenosis 75-95%. Also, patients with a life expectancy of less than 5 years are unlikely to benefit due to high upfront risk of perioperative complications. Lastly, any benefit would be lost if CEA was performed in centers where surgical risk is ≥3%.

Recently, these studies have been under scrutiny because the stroke incidence found in the BMT group was higher in the 1990s (when these studies were conducted) than over the last few years. This has been attributed to advances in medical therapy for stroke patients over the past decade and it has been argued that as long as asymptomatic patients with carotid stenosis are placed onto currently available BMT there may not be a net benefit from CEA over BMT alone.

### Table 1. Number needed to treat (NNT) with carotid endarterectomy to prevent one stroke per year

<table>
<thead>
<tr>
<th>Disease</th>
<th>NNT to avoid one stroke/year*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asymptomatic (60-99%)</td>
<td>85</td>
</tr>
<tr>
<td>Symptomatic (70-99%)</td>
<td>27</td>
</tr>
<tr>
<td>Symptomatic (50-69%)</td>
<td>75</td>
</tr>
<tr>
<td>Symptomatic (&gt;50%) in men</td>
<td>45</td>
</tr>
<tr>
<td>Symptomatic (&gt;50%) in women</td>
<td>180</td>
</tr>
<tr>
<td>Symptomatic (&gt;50%) &gt;75 years</td>
<td>25</td>
</tr>
<tr>
<td>Symptomatic (&gt;50%) &lt;65 years</td>
<td>90</td>
</tr>
<tr>
<td>Symptomatic (&gt;50%) &lt;2 weeks after event</td>
<td>25</td>
</tr>
<tr>
<td>Symptomatic (&gt;50%) &gt;12 weeks after event</td>
<td>625</td>
</tr>
<tr>
<td>Symptomatic (≤50%)</td>
<td>No benefit</td>
</tr>
</tbody>
</table>

*Benefit extends beyond the first year and correspondingly NNTs are much lower for five year outcome data quoted elsewhere in the literature; the main purpose of this table is to serve as a comparator between different patient subgroups.

### 3. CEA for asymptomatic patients requiring CABG:

Another group of patients that is frequently referred for CUS and CEA are pre-operative CABG patients. Intuitively, it makes sense to image these patients as co-morbidity of coronary and cerebrovascular disease is high and peri-operative strokes are not an infrequent complication of CABG. However, most perioperative strokes are actually attributable to cardioembolic disease rather than carotid disease and only very few patients show evidence of injury due to perioperative hypoperfusion related to concurrent carotid stenosis. Moreover, aggressive medical treatment of pre-CABG patients to address the carotid disease versus CEA has not been studied.

The evidence to support CEA pre- or concurrent to CABG remains inconclusive. To date there have been no randomized controlled trials to address this questions. Two reviews summarising a number of case series, retrospective case control studies, and case reports were identified. One concluded that pre-CABG CEA was not supported by the available literature, but that concurrent CABG and CEA should be considered.
where there is a proven surgical risk of <3% and the patient has either unilateral carotid stenosis >60% or bilateral stenosis with the more stenosed side being >75% narrowed. Unfortunately, such a low surgical risk with concurrent CABG and CEA is not easily achieved in this very high risk patient group.

The other review concluded that low risk, younger patients with a significant asymptomatic carotid artery stenosis should be considered for carotid endarterectomy at some stage, but that there is no strong evidence that this must be performed prior to, or during CABG, when surgical risk is highest. More recently, an expert panel discussed this topic and all participants concluded that the available evidence does not support pre-CABG or concurrent CEA, primarily due to the increased surgical risk.

Carotid artery stenting or balloon angioplasty (CAS) has been suggested as an alternative to CEA, but this has not been properly evaluated in this patient group to date. Even in non-CABG patients the use of CAS remains controversial.

4. CAS versus CEA:

As an alternative to CEA, CAS has been assessed in a number of trials and a recent meta-analysis of these studies revealed significantly higher risk of any stroke or death within 30 days of CAS compared with CEA (OR 1.41; 95% CI 1.07-1.87; p=0.016).

Some guidelines still advocate the potential utility of CAS in patients with either medical contraindications to CEA, stenosis at a surgically inaccessible site, re-stenosis after earlier CEA, or post-radiation stenosis, as long as operator complication is well established to be low. However, the NZ stroke guidelines currently do not support the use of CAS in any subgroup of patients due to insufficient evidence.

Recently, the results of the long awaited CREST trial were presented and the results were more promising, showing no significant difference between treatment groups for the combined endpoint of death, stroke or MI. However, it will be important to include this study in a meta-analysis with the previous trials to assess if prior negative results are truly offset and thus it is too early to draw any clear cut conclusions. This has been further highlighted by another recent publication once again establishing CEA as the preferred method over CAS at least until more long term outcome data becomes available.

5. Medical management during the pre- and post-operative periods:

a. Best medical therapy—BMT for most patients with carotid stenosis includes antiplatelet agents (single or combination), a Statin, and oral antihypertensives. Patients awaiting surgery benefit from BMT pre-operatively (including antiplatelets) and long-term post-operatively. This is applicable to both symptomatic and asymptomatic patients with carotid stenosis.

b. Anticoagulants—Some clinicians have advocated the use of intravenous (IV) unfractionated Heparin or subcutaneous (SC) low molecular weight heparin (LMWH) to avoid further TIAs or strokes during the pre-operative waiting period.
Multiple randomized controlled trials have failed to show any benefit of anticoagulation over antiplatelet therapy for extra and/or intracranial atherosclerotic vascular disease, but identified an increased risk of bleeding with anticoagulation. In 21 placebo-controlled trials of several anticoagulant agents in patients with acute ischemic stroke, there was also no net benefit of anticoagulants, since the reduction in the risk of recurrent stroke was offset by the increased risk of brain haemorrhage.

A post-hoc analysis of the TOAST trial suggested that IV administration of Danaparoid may hold some promise in this patient group, but a confirmatory sufficiently powered trial is still outstanding.

Some clinicians still use IV Heparin in TIA patients presenting with crescendo TIAs and high grade carotid stenosis, but this practice has not been conclusively evaluated and is not supported by international stroke guidelines.

c. Clopidogrel plus aspirin—Some experts recommend short-term use of the combination of Clopidogrel plus Aspirin in patients with symptomatic carotid stenosis, borrowing from the cardiac literature; however, studies to support this practice are lacking. Long-term use of this combination in stroke patients has been shown to be harmful. The short-term use for “plaque stabilisation” during the pre-operative period may carry an increased surgical risk due to excessive bleeding. While some surgeons may feel that the bleeding is reasonably controllable, others do not.

6. Carotid imaging:

a. Modality—Conventional carotid angiogram to image carotid arteries is being increasingly replaced by less invasive modalities. Aside from CUS, computed tomography angiogram (CTA), conventional magnetic resonance angiography (MRA), and contrast-enhanced magnetic resonance angiography (CEMRA) are now available.

A recent systematic review found that the non invasive alternatives, including CUS, provide good accuracy in detecting 70-99% internal carotid artery stenosis when compared with conventional angiography. However, CUS in particular is less reliable for 50-69% stenosis with a significant false positive rate.

When comparing amongst the less invasive modalities CEMRA is most accurate followed by CTA and CUS, with routine non-contrast time of flight MRA being the least reliable. CEMRA and CTA are significantly more expensive and not as widely accessible as CUS.

b. Symptomatic patients—“Symptomatic patients” are those who exhibit symptoms consistent with vascular compromise of anterior cerebral, middle cerebral or retinal artery distribution. This can be confirmed by positive brain imaging or suggested by typical anterior circulation symptoms such as dysphasia, other cortical symptoms (e.g. neglect, apraxia, anasognosia), or transient monocular blindness. Hemisensory loss and hemiparesis can also be seen with anterior circulation compromise.
In contrast, symptoms such as vertigo, diplopia, isolated hemianopsia, or cerebellar ataxia suggest posterior (i.e. not carotid) circulation pathology. Patients with TIA or minor stroke symptoms attributable to anterior circulation compromise, who are also considered fit enough and willing to undergo surgery, are the patients who should be considered for urgent carotid imaging (within 24 hours to 7 days depending on risk stratification).\(^{15}\)

c. **Asymptomatic patients**—“Asymptomatic patients” are those who have not had an event attributable to anterior circulation vascular compromise within the preceding three months. This includes most patients undergoing CABG and those with pure posterior circulation symptoms. Limited data is available to help guide which asymptomatic patients are most likely to suffer from severe carotid stenosis. However, some studies have found that the following features are associated with a higher risk of >70\% carotid stenosis: carotid bruits, known carotid disease, prior TIA or stroke, prior myocardial infarction, peripheral vascular disease, diabetes, hypertension, tobacco use, and dyslipidaemia.

The presence of a lacunar stroke had a strong negative correlation with significant carotid stenosis.\(^{57,58}\) Specificity and sensitivity were dependent on the number of risk factors present.\(^{57}\)

d. **Follow-up imaging**—Post-operative and surveillance CUS to assess for plaque recurrence or progression is frequently pursued (local audits), but neither practice has been subjected to randomized controlled trials to assess for efficacy. Available data is derived from small case series and retrospective case control studies.

   i. **Post-CEA surveillance for restenosis**—The post-operative restenosis rate ranges from 6-14\%\(^{59-62}\) dropping progressively (10\% first year, 3\% second year, 2\% third year).\(^{60}\) Post CEA stroke occurs in 4.8\% (0.3-7.9\%) over an average follow-up of 4.5 years (18-120 months).\(^{63-71}\) However, >50\% of post-CEA strokes are not attributable to ipsilateral restenosis and restenosis itself does not clearly predict an increased risk of stroke. In fact the only significant risk factor for post-CEA stroke is contralateral stenosis of >50\% at time of surgery and may thus be the only good reason to warrant post-operative CUS aside from recurrent anterior circulation symptoms.\(^{64,68,73-75}\) This approach was supported by two papers assessing cost effectiveness of post-CEA CUS surveillance.\(^{69,75}\) The yield of early re-scanning (<3 months) and frequent repeat scans (< 12 months) was not justifiable based on outcome data.\(^{51}\)

While patients with symptomatic restenosis generally benefit from repeat surgical intervention there is no consensus about asymptomatic patients, although the same criteria as for non-post-CEA patients are generally applied.

   ii. **Surveillance for disease progression**—The stroke risk in asymptomatic patients followed serially with CUS ranges from 0.4\%-1\% per year.\(^{71,79}\) Despite this overall low stroke risk, progression from
moderate to severe stenosis on repeat CUS has been reported to be as high as 20-22% at three years\textsuperscript{77, 78} and progression of carotid stenosis appears to identify a subgroup of patients at higher risk of future stroke.\textsuperscript{25, 76} However, whether this increase in stroke risk is significant enough to warrant ongoing surveillance or if surveillance is even an effective measure to prevent such strokes has been drawn into question.\textsuperscript{71, 79}

C. REGIONAL CONSENSUS

1. Carotid ultrasound utilization:

a. Symptomatic patients—CUS should be offered to patients who are likely to have suffered an anterior circulation TIA/non-disabling stroke, are reasonable surgical candidates, and are willing to undergo surgery.
   
   i. TIA/non-disabling stroke symptoms—symptoms should be of sudden onset and of maximal intensity at onset with other diagnoses being less likely.
   
   ii. Anterior circulation symptoms—one or more of the following has to be present: unilateral numbness, unilateral weakness, dysphasia, or other cortical symptom and patient does not have cerebellar symptoms, diplopia, dizziness/vertigo, or syncope.
   
   iii. Reasonable surgical candidate—low to moderate peri-operative risk and non-disabling stroke or TIA symptoms with reasonable baseline level of functioning (e.g. patient should not be plegic, fully dependent, terminally ill or demented)
   
   iv. Timing—CUS should be obtained within 24 hours in patients with ABCD2 score of >3, crescendo TIA, or ongoing non-disabling stroke symptoms. CUS should be obtained within 7 days in all remaining patients that meet criteria i.-iii.

b. Asymptomatic patients: In centres were CUS services are limited, scanning of asymptomatic individuals could be limited to the private sector. To ensure that the yield is sufficiently high, imaging should be limited to patients who meet the following criteria:

   i. “Favourable” patient profile with at least some if not all of the following: Male, <75 years old, >5-year life expectancy, very low peri-operative risk AND

   ii. Carotid bruit is present AND

   iii. Prior history, even remote, of non-lacunar TIA/stroke OR

   iv. Diabetes OR

   v. Two or more of the following: hypertension, dyslipidaemia, smoker, concurrent coronary or peripheral vascular disease

   c. Surveillance scans of mild-moderate stenosis—in patients with 50-69% stenosis who did not undergo CEA and who are male, <65 years old, have a life expectancy of >5 years, and have a very low peri-operative risk a single
follow-up CUS should be considered at about 1-2 years to evaluate for progression to ≥70%. Ongoing surveillance or routine follow-up for all patients with some degree of carotid stenosis has a low yield and is unlikely to be cost-effective, or even achievable, in the current setting of limited access to carotid imaging.

d. Post surgical requests—Post CEA it is reasonable to obtain a single follow-up ultrasound. If a restenosis is felt to be likely due to peri-operative difficulties this should be performed about 3-6 months post surgery. If surgery was uncomplicated follow-up scanning should be delayed to 6-12 months to increase yield.

e. Pre-CABG imaging—this practice is controversial and requires further discussion with cardiologists and cardiothoracic surgeons – a consensus was not reached.

f. Pre-operative rescanning—Repeat carotid imaging prior to surgery should be considered in patients who have been waiting for an extended period to exclude interim change. Patients with carotid stenosis of 50-69% on CUS should be considered for CTA or CEMRA prior to CEA to confirm degree of stenosis if at all feasible and if unlikely to delay surgical intervention >2 weeks from symptoms onset.

2. Step-by-step management guidelines for potential CEA candidates:

a. Symptomatic patients—

1. TIA/non-disabling stroke diagnosis is made
2. Anterior circulation compromise is deemed likely
3. Patient is agreeable to undergo surgery, and deemed a good surgical candidate
4. CUS is obtained within 24 hours to 7 days depending on risk assessment
5. On call vascular surgery consultant is called if ipsilateral stenosis is confirmed and measures
   i. 70-99% or
   ii. 50-69% plus favourable patient profile (>75 years of age, male, and hemispheric stroke or TIA)
6. Patient is scheduled for surgery
   i. within a maximum of 2 weeks of symptom onset for most candidates
   ii. within 48-72 hours if crescendo TIAs or very high grade stenosis (but <99%) is present
7. Images are transferred to Capital and Coast DHB via PACS (if available)
8. Standardised referral is completed and emailed or faxed to the surgeon (Appendix A)

9. Clopidogrel is avoided during the pre-operative period

10. Aspirin, Dipyridamole, Statin, and anti-hypertensives should be continued

11. IV Heparin, Enoxaparin, or Warfarin should not be used routinely as a bridging therapy

b. Symptomatic late presenters—

1. Patients who present >2 weeks since symptom onset and have ipsilateral stenosis of
   i. 70-99% are triaged to undergo CEA within 4 weeks
   ii. 50-69% should not be offered CEA

2. Patients who present >3 months since symptom onset are to be considered as asymptomatic candidates (see below).

c. Asymptomatic patients—

1. Patient meets criteria as outlined under C.1.b-d

2. Non-urgent imaging is arranged

3. Routine outpatient referral to vascular surgeon is sent via mail if:
   i. stenosis of at least 70% is identified AND
   ii. it is confirmed that the patient has at least some if not all of the following “favourable characteristics:” male, <75 years old, life expectancy of >5 years, very low peri-operative risk, progression on CUS

4. All patients considered for surgical referral should be counselled on the available data and active patient involvement in the decision making process should be encouraged

5. Prioritisation for surgery of these patients will be low and wait times may be up to 6-12 months

7. Because of the small benefit of CEA in these patients some consideration could be given to performing these procedures preferentially in the private sector

8. All patients with identified carotid artery stenosis, whether referred for surgery or not, should be placed on best medical management to reduce the risk of future stroke

d. Pre-CABG patients—Insufficient evidence was identified to support routine CEA combined with CABG or pre- CABG in patients with asymptomatic carotid stenosis awaiting coronary bypass surgery. In light of limited access to CUS and CEA this practice should be further reviewed. However, this consensus group felt that specific recommendations should be
arrived at after further consultation with cardiologists and cardiothoracic surgeons.

3. Miscellaneous:

a. Carotid artery stenting—CAS is inferior to CEA and should not be routinely considered. CAS may be considered in some patients with stenosis at a surgically inaccessible site or post-radiation stenosis. This decision is at the discretion of the involved vascular surgeon.

b. CEA risk assessment—Periodic auditing of surgical complications should be undertaken and should include a non-surgeon stroke physician or neurologist to ensure that surgical risk remains below <3% for asymptomatic and symptomatic patients with 50-69% stenosis and <6% for symptomatic patients with 70-99% stenosis.

c. Assessing degree of carotid stenosis—All involved clinicians should preferentially use NSCET criteria for assessing degree of carotid stenosis and this should be confirmed with each local radiology department.

D. REFERRER DEMOGRAPHICS

Stroke specialist/neurologist involvement is encouraged prior to referral for surgery. However, if this is likely to cause significant treatment delays then GPs or other medical specialists may refer symptomatic patients directly for surgery using the same criteria as outlined above.

Conclusion

Carotid endarterectomy is an effective therapy for the prevention of stroke. However, in order to maximise the benefit, patients have to be selected carefully. In an environment of limited resources and often long waiting times for diagnostics and procedures it is vital to give high priority to those patients who are likely to benefit the most.

If many geographically separated physicians refer to a single small group of surgeons it is also important that selection criteria and referral processes are agreed upon to ensure that patients are treated equitably throughout the region. A region-wide management consensus can also help local physicians to justify management decisions amongst their own colleagues and managers. It is hoped that this consensus will achieve a more standardised approach resulting in shorter waiting times for diagnostics and surgery, fewer preventable strokes, and fewer unnecessary diagnostics and surgeries. It is anticipated that this will not only improve patient care, but may also serve as a model for enhancing efficiency and cost effectiveness of health care delivery across a wider region.

As further scientific data emerges recommendations will have to be reviewed and future forums may expand to include general, neuro-, and interventional radiologists, cardiologists, and cardiothoracic surgeons to get an even more comprehensive perspective on the issues at hand.
Competing interests: None.

Author information: Annemarei Ranta, Neurologist, Pietro Cariga, Neurologist, John Bourke, Geriatrician, Tamlin Clulow, Medical House Surgeon, MidCentral DHB, Palmerston North; Dilip Naik, Vascular Surgeon, Richard Evans, Vascular Surgeon, Anantha Ramanathan, Vascular Surgeon, Danella Fawat, Vascular Surgical Registrar, Department of Vascular Surgery, Capital and Coast DHB, Wellington; Gerry McGonigal, Geriatrician, Stuart Mossman, Neurologist, Per Holmberg, David Abernethy, Neurologist; Lindsay Haas, Neurologist, Department of Neurology, Capital and Coast DHB, Wellington; Tim Matthews, General Physician, Wairarapa DHB, Masterton; Tom Thomson, General Physician, Yun Lee, Geriatrician, Department of Medicine, Hutt Valley DHB, Lower Hutt; Tom Thompson, General Physician, Whanganui DHB, Wanganui

Acknowledgements: The authors would like to thank Drs Alan Barber, John Fink, and John Gommans for their valuable comments and feedback.

Correspondence: Dr Annemarei Ranta, Department of Neurology, MidCentral Health, Private Bag 11036, Palmerston North 4442, New Zealand. Fax: +64 (0)6 3508391; email: anna.ranta@midcentraldhb.govt.nz

References:


## Appendix A

**Carotid Endarterectomy Regional Referral Form**

### Patient label or fill in:

<table>
<thead>
<tr>
<th>Patient Name:</th>
<th>Gender:</th>
<th>☐ male ☐ female</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHI:</td>
<td>Address:</td>
<td></td>
</tr>
<tr>
<td>DOB:</td>
<td>Hospital:</td>
<td></td>
</tr>
<tr>
<td>Phone:</td>
<td>GP:</td>
<td></td>
</tr>
</tbody>
</table>

- **Surgeon contacted by phone:**
- **Referrer:**
- **Phone:**
- **Fax:**
- **Email:**
- **Patient Cell (if available):**

### Date of event (if any):

- **Type of event:** ☐ TIA  ☐ Stroke

### ABCD2 score:

- **Number of events/time:**
- **Symptoms:** ☐ right/☐ left

### Relevant pre-op neurological exam findings:

- **Suggested time frame for CEA:** ☐ 1-3 days  ☐ 3-14 days  ☐ >14 days OK
- **Brain Imaging:** CT☐ MRI☐ Result:
- **Carotid Imaging:** Carotid U/S☐ MRA☐ CTA☐ Conv. Angiogram☐
- **Result:** Left ICA: Right ICA:
- **Other:**
- **Reports attached?:** yes☐ no☐ if no, reason:
- **Medications:**

### PMH (especially as might pertinent to surgical risk):

### Any other relevant information:

____________________  _______________

Referrer Signature     Date