Imaging transient ischaemic attacks (TIAs) - Are we compliant with the national guidelines?

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Purpose

A transient ischaemic attack is defined as stroke symptoms and signs that resolve within 24 hours [1]. Sometimes known as minor stroke, in which blood supply to the brain is temporarily disturbed leading to stroke like symptoms, but where these symptoms resolve within 24 hours. The cause of TIA is the same as the cause of an ischaemic stroke.

TIAs carry a significant mortality and morbidity risk. They may be the only warning that a major stroke is imminent [2]. There is a 20 percent risk of full stroke within the first four weeks after TIA [3]. Around 150,000 people per year have a suspected TIA or minor stroke [4]. However, only 35 percent are seen and investigated in a neurovascular clinic within seven days [3].

Investigating and treating high-risk patients with TIA within 24 hours could reduce by 80 percent the number of people who go on to have a full stroke [5]. The risk of stroke is greatest immediately after a new TIA. ABCD2 scoring system (table 1) determines the likely risk of subsequent stroke.

Table 1: ABCD2 score

• Age # 60? +1
• BP # 140/90 mmHg at initial evaluation? +1

Clinical Features of the TIA:

Unilateral Weakness? +2
Speech Disturbance without Weakness? +1

Duration of Symptoms:

10-59 minutes? +1
# 60 minutes? +2

Diabetes Mellitus? +1

People who have had a suspected TIA who are at high risk of stroke (ABCD2≥4/crescendo TIA) in whom the vascular territory or pathology is uncertain should undergo urgent brain imaging within 24 hours whereas people who have had a suspected TIA who are at lower risk of stroke (ABCD2<4) in whom the vascular territory or pathology is uncertain should undergo brain imaging within 7 days at the most [1,2].
Approximately 50 percent of suspected TIAs require magnetic resonance imaging (MRI) of the brain [2]. MRI in TIA needs to include diffusion-weighted imaging (DWI, which shows lesions in up to half of TIAs) and gradient-echo sequences (GRE, which is very sensitive to bleeding). Magnetic resonance angiography (MRA) will also be appropriate to clarify the arteries affected in many instances. Computed tomography (CT) has low spatial resolution and may be unable to detect small lesions. It may, however, remain an appropriate alternative in those for whom MRI is contraindicated.

About 80 percent of TIAs require imaging of the carotid arteries. The remaining 20 percent of people have a vertebrobasilar TIA (brainstem/ cerebellum) and will not benefit from carotid imaging [2]. Carotid imaging requires assessment of severity of stenosis at the carotid bifurcation and exclusion of an embolic source in the carotid arteries or elsewhere.

Duplex ultrasound is the most widely available and frequently used initial investigation for assessment of carotid stenosis. However, duplex ultrasound is operator dependent requiring significant skill in image and data acquisition as well as interpretation. Evidence suggests that more recently introduced non-invasive imaging modalities, especially contrast enhanced magnetic resonance angiography (CEMRA) may be more accurate [6]. Exclusion of other sources of emboli will require overview imaging techniques that can image from the origin of the carotid artery to the circle of Willis within the brain including CEMRA and CT angiography (CTA). In rare cases, clots can be formed within the heart for which echocardiography may be required.

Carotid imaging can identify those people with significant carotid stenosis who would benefit from carotid intervention (carotid endartrectomy/ stenting) in order to prevent stroke. Significant disease is usually defined as symptomatic carotid stenosis of 50-99% using criteria from North America Symptomatic Endartrectomy Trial (NASCET) [7,8] or 70-99% using criteria from European Carotid Surgery Trialists' (ECST) Collaborative Group [9]. A NASCET stenosis value of 50% is broadly equivalent to a 70% value in ECST [10]. Table 2 demonstrates urgency of brain imaging, carotid imaging/intervention based on the predicted risk of stroke.

Table 2: Urgency of brain imaging, carotid imaging/intervention in suspected TIA

**High risk of stroke (ABCD2#4/crescendo TIA)**

- Brain imaging (MRI/MRA, CT/CTA if MRI is contraindicated): within 24 hours
- Carotid imaging (duplex scan, CEMRA, CTA): within 24 hours
- Carotid intervention (NASCET 50-99%, ECST 70-99%): within 48 hours

**Low risk of stroke (ABCD2<4)**
- Brain imaging (MRI/MRA, CT/CTA if MRI is contraindicated): within 7 days at the most
- Carotid imaging (duplex scan, CEMRA, CTA): within 7 days at the most
- Carotid intervention (NASCET 50-99%, ECST 70-99%): within 14 days

# symptomatic carotid stenosis of <50% using NASCET criteria, or <70% using ECST criteria are managed medically and no surgical intervention is indicated.

The aim of this audit is to compare our local practice in imaging TIAs with nationally agreed guidelines [1,2].
Fig. 2: The CT scan of a 63-year-old woman with acute-onset isolated right arm weakness performed 11.75 hours after the onset was normal. MRI was performed 13.5 hours after onset, which was 3 hours after admission. A, T2-weighted images were normal. Diffusion-weighted sequences showed lesions (arrows) of right frontal lobe white matter (B), left occipital pole and posterior right temporal lobe (C), and left motor strip (D), consistent with multiple emboli. ADC sequences showed correlation of low intensity at all sites, consistent with acute ischemia. TOAST diagnosis changed from stroke of undetermined etiology to cardioembolic. Transesophageal echocardiogram demonstrated marantic endocarditis.
Fig. 3: The CT scan of a 67-year-old man with dysarthria and right facial droop on awakening performed 17.25 hours after onset showed no lesion. MRI was performed 36.5 hours after onset, which was 21.5 hours after admission. A, T2-weighted MRI showed multiple foci of increased signal in bilateral deep white matter (arrows). B, DWI demonstrates acute lesion in left posterior internal capsule. ADC sequences showed correlation of low intensity, consistent with acute ischemia. C, MRA displayed stenotic left M1 portion of middle cerebral artery (arrow) and atherosclerotic irregularity of cavernous portion of left internal carotid artery (arrow). TOAST diagnosis changed from small-vessel etiology to more than 1 likely etiology (both large-vessel atherothromboembolic and small-vessel possible).

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**Fig. 4:** Fibrous cap enhancement after gadolinium-contrast administration. CEMRA shows the position of a Black Blood MRI (BBMRI) slice (line, A). Pre- (B) and postcontrast (C) BBMRI images through the plaque show cap enhancement (black arrows) and a large lipid core (white arrow). *Internal carotid artery lumen. Arrowhead indicates ulceration.*

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Methods and Materials

Case notes of patients presented with clinical symptoms and signs suggestive of TIA over a period of fifteen months where retrospectively identified and reviewed. This included patients who have been referred electively by general practitioners to the nurse practitioner unit and those who have been admitted to the medical assessment unit (MAU) through accident and emergency department (A&E).

Patients were risk stratified into high risk (ABCD2≥4) and low risk (ABCD2<4). Note review included age and sex of the patient, whether MRI of the brain has been done within time (24 hours for ABCD2≥4, and 7 days for ABCD2<4), whether carotid duplex has been done within time (24 hours for ABCD2≥4, and 7 days for ABCD2<4) and finally whether vascular referral has been done within time (48 hours for ABCD2≥4, and 14 days for ABCD2<4) when indicated (stenosis of 50-99% using NASCET criteria, or 70-99% using ECST criteria).
Results

A total of 40 patients (23 males, 17 females; age range 35-90 years) have been referred to hospital with TIA. Only four patients (10%) underwent MRI studies, none of which was done within time (0%). None of the study group had a vascular territory confirmed nor a contraindication for MRI identified.

CT scans were done for 38 patients (95%) of which 35 patients (92%) had their CT done within time. Of the 38 CT studies which were done, CT confirmed ischaemia in only 7 patients (18%) whereas CT studies for the rest of the patients were normal (31, 82%).

Two patients with ABCD2<4 and two patients with ABCD2#4 underwent MRI studies after 7 days and 2 days respectively after their CT results were found normal. MRI of one of the patients belonging to the first group revealed focal ischaemic changes of carotid artery territory. The remaining three MRI studies were normal.

All 40 patients, after a specialist assessment on presentation, were found to have non-cardio-embolic, carotid-territory minor stroke and they were all deemed fit for carotid intervention if indicated. Neither of the brain imaging modalities (CT/MRI) confirmed vertebro-basillar territory ischaemia. Accordingly, all the 40 patients who were referred with TIA needed carotid imaging [2].

Eighteen carotid studies were done overall (45%), 6 (33%) were done within time. For two patients (5%) there were clear justified reasons why carotid duplex was not performed. One patient failed to attend the appointment. The second patient has had CTA which revealed no critical stenosis of the carotid artery that merits surgical intervention. However, this CTA was not done within time (done within 5 days for ABCD2 score of 4).

Half of the patients (20, 50%) did not undergo carotid duplex studies for non justifiable reasons (no mention of patient's non fitness for carotid intervention, no alternative vascular imaging used and no confirmation of vertebral-territory involvement). Fifteen out of the total eighteen patients who underwent carotid duplex studies did not show severe carotid stenosis (NASCET<50%, ECST<70%). The remaining three patients (17%) had severe stenosis (NASCET 50-99%, ECST 70-99%). No vascular referral was done within time for either one. Table 3 shows the distribution of the patients according to their ABCD2 score.

Table 3: patients' distribution accoridng to their ABCD2 score
16 (40%) patients presented with ABCD2<4 (9 males, 7 females; age range 35-85 years) whereas 24 (60%) patients presented with ABCD2#4 (14 males, 10 females; age range 46-90 years). Table 4 shows patients’ demographics for all patients and two subgroups, and table 5 shows imaging outcome for all patients and the two subgroups.

Table 4: patients’ demographics

<table>
<thead>
<tr>
<th>ABCD2 score</th>
<th>demographics</th>
</tr>
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<tbody>
<tr>
<td>1-6 (all)</td>
<td>40 (100%)</td>
</tr>
<tr>
<td></td>
<td>males 23 (57%)</td>
</tr>
<tr>
<td></td>
<td>females 17 (43%)</td>
</tr>
<tr>
<td></td>
<td>age range 35-90 years</td>
</tr>
<tr>
<td></td>
<td>average 71</td>
</tr>
<tr>
<td>&lt;4</td>
<td>16 (40%)</td>
</tr>
<tr>
<td></td>
<td>males 9 (56%)</td>
</tr>
<tr>
<td></td>
<td>females 7 (44%)</td>
</tr>
<tr>
<td></td>
<td>age range 35-85 years</td>
</tr>
<tr>
<td></td>
<td>average 73</td>
</tr>
<tr>
<td>#4</td>
<td>24 (60%)</td>
</tr>
<tr>
<td></td>
<td>males 14 (58%)</td>
</tr>
<tr>
<td></td>
<td>females 10 (42%)</td>
</tr>
</tbody>
</table>
age range 46-90 years

average 78

Table 5: imaging outcome

<table>
<thead>
<tr>
<th>ABCD2 score</th>
<th>MRI</th>
<th></th>
<th>CT</th>
<th></th>
<th>Carotid doppler</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Within time</td>
<td>overall</td>
<td>Within time</td>
<td>overall</td>
<td>Within time</td>
<td>overall</td>
</tr>
<tr>
<td>&lt;4 (16)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>13 (81%)</td>
<td>14 (87%)</td>
<td>1 (6%)</td>
<td>5 (31%)</td>
</tr>
<tr>
<td>#4 (24)</td>
<td>0 (0%)</td>
<td>4 (16%)</td>
<td>22 (91%)</td>
<td>24 (100%)</td>
<td>5 (20%)</td>
<td>13 (54%)</td>
</tr>
<tr>
<td>All (40)</td>
<td>0 (0%)</td>
<td>4 (16%)</td>
<td>35 (92%)</td>
<td>38 (95%)</td>
<td>6 (33%)</td>
<td>18 (45%)</td>
</tr>
</tbody>
</table>
Conclusion

This audit showed poor compliance with national guidelines in imaging TIAs.

recommendations were made to improve adherence to the standard practice, including the following:

- local referral protocols should be agreed between primary and secondary care to facilitate the timely assessment of people who have had a TIA or minor stroke
- investing in imaging services to diagnose TIA and stroke as management of subsequent risk of stroke will result in savings to acute care costs, where more strokes will be prevented.
- establishing a clear pathway for managing TIA locally in the hospital to be used in A&E and MAU.
- establishing a pathway for carotid intervention.
- liaison with radiology department to determine if there is a feasible mechanism for expediting investigations (e.g. reserved slots) and to allow development of agreed pathways for imaging, and
- assessment of where the delays are; in requesting a radiological investigation or in delivering the service by the radiology department?
References

9. European Carotid Surgery Trialists’ Collaborative Group. MRC European Carotid Surgery Trial: interim results for symptomatic patients with severe (70-99%) or with mild (0-29%) carotid stenosis. Lancet 1991; 337-1235