Clinical and imaging services for TIA and minor stroke in the UK – results of two clinical surveys

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Title: Clinical and imaging services for TIA and minor stroke– results of two surveys of practice across the UK

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ARTICLE SUMMARY

Article focus

- Is the current provision of stroke prevention clinical services adequate to meet the volume of work in the UK?
- Is access to brain and carotid imaging adequate to meet the demand and is imaging being used efficiently?
- Who is providing these services?

Key Messages

- Most responding centres had some form of rapid access stroke prevention clinic.
- Front line assessment was by nurses in nearly a third of clinics, but about half of patients have a TIA mimic which requires medical expertise for diagnosis.
- There was efficient use CT brain and carotid ultrasound imaging, but less good access to MR brain imaging and this was often used incorrectly or inefficiently.

Strengths and limitations

- The survey covered the whole of the UK and achieved a 45% response rate.
- Clinical and imaging services responses were highly concurrent.
- Services may be much worse in areas that did not respond.

ABSTRACT

Objectives

Transient ischaemic attack (TIA) is a medical emergency requiring rapid access to effective, organised, stroke prevention. There are about 90,000 TIAs per year in the UK. We assessed whether stroke prevention services in the UK meet Government targets.

Design

Cross-sectional survey.

Setting

All UK clinical and imaging stroke prevention services.

Intervention

Electronic structured survey delivered over the web with automatic recording of responses into a database. Reminders to non respondents. The survey sought information on clinic frequency, staff, casemix, details of brain and carotid artery imaging, medical and surgical treatments.

Results

114 stroke clinical and 146 imaging surveys were completed (both response rates 45%). Stroke prevention services were available in most (97%) centres but only 31% operated 7 days per week. Half of clinic referrals were TIA mimics, most patients (75%) were prescribed secondary prevention prior to clinic referral, and nurses performed the medical assessment in 28% of centres. CT was the most common and fastest first-line investigation; MR, used in 51% of centres, mostly after CT, was delayed up to two weeks in 26%; 51% of centres omitted blood-sensitive (GRE/T2*) MR sequences. Carotid imaging was with ultrasound in 95% of centres and 59% performed endarterectomy within one week of deciding to operate.

Conclusions

Stroke prevention services are widely available in the UK. Delays to MRI, its use in addition to CT while omitting key sequences to diagnose haemorrhage, limit the potential benefit of MRI in stroke prevention, but inflate costs. Assessing TIA mimics requires clinical neurology expertise yet nurses run 28% of clinics. Further improvements are still required for optimal stroke prevention.

BACKGROUND

TIA and minor stroke are medical emergencies. In the UK there are 80,000 to 90,000 TIAs and minor strokes every year.[1, 2] The benefit of medical or surgical treatment to prevent recurrent stroke after TIA is greatest if given as early as possible;[3-5] the benefit falls rapidly with increasing delay.[6, 7] Patients with TIA and minor stroke need a rapid, comprehensive assessment and active management to reduce the short and long term risks of recurrent stroke. Establishing an accurate diagnosis and delivering effective stroke prevention is challenging and requires organised stroke services. NHS Improvement in England introduced tariffs to encourage the establishment of stroke prevention services which meet key performance criteria; there are supplementary tariffs for achieving optimum management of high risk TIA patients, including use of MRI.[8, 9] We surveyed UK clinical and imaging secondary stroke prevention services to determine their performance against recent guidelines.[10]

METHODS

We devised two electronic survey questionnaires, one for clinical stroke prevention services and one for imaging services using the online survey software 'SurveyMonkey' (www.surveymonkey.com). These were informed by previous questionnaires sent to stroke services which achieved high response rates.[11-13] We used a 'closed', 'structured' response format. Both questionnaires provided information on the rationale and purpose of the study, including details of the research team, and incorporated best research practice issues such as confidentiality and informed consent.

Following pilot testing, the agreed versions of the survey questionnaires (available on request) contained detailed questions addressing the current provision of stroke prevention services (56 questions) and imaging services (47 questions) focusing on the volume of work, capacity, professionals involved, type and timing of brain and carotid imaging (within or outside normal office hours, for inpatients or outpatients), and carotid endarterectomy rates. We considered eligible participants to be all clinical leads of UK stroke services and radiology departments.

We offered no incentives to participate in the surveys. The responses were completely anonymous and completion was voluntary hence approval of Ethics Committees was not required. We sent letters of invitation explaining the objectives and providing links to access the questionnaires online in April 2011 by email or post, via multiple routes, to all UK stroke clinical leads and Radiology Directorates, including: stroke leads of all 15 NHS Boards in Scotland through the Scottish Stroke Care Audit; the 27 stroke networks (with three to nine clinical sites within each network) through NHS Improvement following contact with the Department of Health; to Stroke Leads in Trust Hospitals through the Royal College of Physicians Sentinel Stroke Audit database; to Radiology Directorate Leads in England through NHS Improvement and the Magnetic resonance National Evaluation Team (MagNET) database; all 12 Scottish Clinical Directors of Radiology through the Diagnostic Imaging Clinical Network; and to clinical and imaging stroke services in Wales through the Stroke Collaborative. The surveys went to 171 Acute Trusts, 129 Foundation Trusts, and seven Welsh Trusts and hospitals in the 15 NHS Boards in Scotland. Details of the surveys and the online links were also disseminated through the Royal College of Physicians website and advertised through the NHS Improvement Stroke and Radiology newsletters. Reminder messages were sent to non-respondents in June 2011.

Data management and analysis

The results of both internet surveys were reported according to the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) statement.[14]

Surveys results were generated using SurveyMonkey software and entered into an Excel spreadsheet. We expressed the clinical leads' answers as proportions, medians, or means. Not all respondents answered all the questions, therefore the percentages reported are of the actual numbers of respondents. To calculate the response rate, we divided the number of clinical leads to whom we initially sent the invitation to participate by the number of participants who actually completed the online questionnaires. However, as both surveys were also disseminated and advertised through professional body websites and newsletters, it was not feasible to calculate the exact number of all

potential respondents contacted. The surveys were completed anonymously therefore it was not possible to associate services with geographical location.

RESULTS

One hundred and fourteen Stroke Service surveys and 146 Imaging Service surveys were partially or fully completed, a response rate of 45% for each.

Stroke prevention clinics. Among the 114 respondents, the mean catchment population was 400,000 people (median 300,000); 97% indicated that their hospital had a specialist stroke prevention clinic. The service was run at least once a week in 99%; every weekday in 47%; and every day in 31%. Most centres (86%, 88/102 respondents) saw between one and five new patients per clinic. In half of the clinics (51/102 respondents), the estimated proportion of patients ultimately diagnosed as TIA/minor stroke mimics was 41-60%; in 31% of centres it was between 60-79%. In only 16% of centres did definite TIA/minor strokes make up the majority (61-100%) of attendees (figure 1).

Thirty-five percent of the TIA/minor stroke patients were seen by the stroke prevention clinic within 24 hours, 25% between 2-3 days, and about 20% within one week of their symptoms. Thirteen percent of centres indicated that patients considered at high risk according to the ABCD2 risk prediction score were seen within 24 hours of referral and low risk patients within seven days.

Most stroke prevention clinics were run by consultants (stroke physicians; neurologists; geriatricians). However, the main medical assessment/triaging was undertaken by nurses in 28% of centres. The final diagnosis was established either with input from, or by a consultant in 71% of centres.

In most centres, most patients seen at the specialist stroke prevention service had already been prescribed secondary prevention drugs (e.g. aspirin; statins) for their recent suspected TIA/minor stroke by their referring doctor (supplementary table 1).

Brain imaging of TIA/minor stroke

The stroke services survey showed that CT was routinely used as the main brain imaging modality in 84% (98/114 respondents) and that MRI was used in only 51% of centres for stroke prevention. This concurred very closely with the imaging services survey which showed that CT was the main modality in most departments (86%, 49/57 respondents). Details of access to CT and MR are provided in supplementary Tables 2 and 3. The stroke prevention and imaging surveys both also showed that most patients were having CT as first line test (figure 2a and figure 2b). The proportion of TIA/minor stroke patients for whom a subsequent MRI was requested after an initial CT varied considerably (range 0%-60%) (supplementary figure 1), the waiting time for MR after CT being one month in about half of centres (47%). The results of brain imaging were returned to the stroke service on the day of scanning in 66% of centres; for 22%, however, it took more than 2 days. In most centres (76%), positive brain imaging results (e.g. haemorrhage) were provided to the stroke prevention clinic immediately.

The routine MR sequences used for TIA/minor stroke were primarily focused on detecting ischaemia: T1-weighted or T2-weighted, diffusion-weighted imaging (DWI), and Fluid Attenuated Inversion Recovery (FLAIR) sequences. Fewer than half of the departments (49%) performed sequences that are sensitive to haemorrhage (e.g. gradient echo, GRE/T2*, supplementary figure 2). Some departments (18%) used only DWI and T2-weighted sequences routinely, thus limiting the chance of detecting either cerebral haemorrhage or non-vascular brain lesions that mimic stroke/TIA.

Carotid artery imaging and endarterectomy

Carotid artery imaging most frequently took place the day of the clinic (47%, 47/100 respondents). Doppler ultrasound (DUS) was the first line carotid/vertebral imaging in most centres (95%). Most centres (80%) provided the results of carotid artery imaging on the same day, and most centres (86%; 85/99 respondents) provided important positive results immediately. A repeat DUS (19%), or CTA (60%) or contrast MRA (41% of centres) were used as confirmatory tests prior to referral for endarterectomy.

The time between the decision to perform a carotid endarterectomy and the actual surgical procedure was less than one week in 59% of centres and between one and three weeks in approximately 37% of centres (supplementary figure 3). No stroke service performed endarterectomy more than six months after the decision to operate.

Workload volume and capacity

During 2010, on average 4,905 CT brain scans were performed per radiology department (range 20-48,346; median 2,500), 18% were conducted out-of-hours but with considerable variation. On average 686 CT brain scans were for patients with suspected TIA/minor stroke (range 0-5,000 scans; median 200 scans), i.e. about 14% of the total workload. On average, 9% of these CT scans were performed out-of-hours (range 0-60% scans; median 2% scans).

During 2010, on average 2,888 brain MR images were performed per radiology department (range 20-24,391 scans; median 1,530 scans), only 3% of MR scans were conducted out-of-hours (most performed no MR brain imaging out-of-hours). On average, 258 MR brain scans were conducted on patients suspected of TIA/minor stroke (range 0-1,200 scans; median 100 scans), ie about 9% of the total workload.

Forty-three percent of the stroke prevention centres indicated that they had spare capacity to see further patients. Responses varied as to what extra facilities were required to expand the current stroke service (figure 3), 'more consultants' being the most frequent, but 'more carotid imaging' was required in 53%. When 'more brain imaging' was chosen, all respondents opted for more MRI (38/38 respondents) rather than CT (14/38).

DISCUSSION

These simultaneous surveys of stroke prevention clinics and imaging services indicate that the necessary components of stroke prevention services are widely available in the UK, but their structure

and organisation vary considerably and an important proportion of practice remains suboptimal (Table 1). In most centres (78%), specialist stroke prevention services operate every weekday with on average five new patients attending each clinic yet only 60% of patients were seen within one week of their event. Additionally, over half the case-load are patients with a final diagnosis of a non TIA/minor stroke 'mimic'. Specialist medical knowledge is required for accurate diagnosis and appropriate medical management of this very heterogeneous case-mix, yet in a quarter of clinics, the main assessment is by nurses.

Table 1. Key findings.

- Nurses provide the primary assessment and diagnosis in nearly a third of clinics;
- 50% of patients attending these clinics have TIA/minor stroke mimic;
- Most patients (75%) have already started secondary prevention treatment before attending the clinic;
- CT for TIA and minor stroke is widely available (94%), is the first line test in the vast majority of centres, and is routinely used in 82%;
- MR is available for TIA and minor stroke patients in 88% of centres but in about half of those it is after an initial CT scan
- There are long delays to MR imaging;
- The key MR sequence needed to diagnose haemorrhage is omitted in more than half of centres, reducing the value of MR;
- Ultrasound is the primary carotid imaging test in 95% of centres;
- There is limited capacity to undertake more imaging although about 40% of stroke services indicated that they had capacity to see more patients; however the main barrier to seeing more patients was the limited availability of MR.

The consistency between the clinical services' and imaging departments' responses to the question about first line imaging method is striking (figure 2a and figure 2b). Both CT and MR are widely available but access to CT is more rapid and more complete than for MR, particularly outside normal office hours and for outpatients (Supplementary tables 2 and 3). MR was commonly performed in addition to and after CT – possibly somewhat inappropriately since the diagnostic yield from MR for ischaemic lesions on diffusion imaging declines rapidly with time after the event.[15] Furthermore, in more than half the centres, the key MR sequence required to identify haemorrhage accurately (i.e.

GRE/T2* or equivalent) was omitted (Supplementary figure 2),[16] increasing the risk that haemorrhages would be misdiagnosed as ischaemic events[17] (one of the two main reasons for brain imaging in TIA/minor stroke) leading to these patients receiving potentially inappropriate antithrombotic or anticoagulant treatment or even offered inappropriate carotid endarterectomy. Some centres that only use DWI and T2 are also likely to miss some stroke/TIA mimics that could otherwise be diagnosed with MR (the other of the two main reasons for brain imaging in TIA/minor stroke). Most patients had already been started on secondary prevention by their GPs before they reached the clinic (supplementary table 1), further questioning the value of MR performed in addition to CT, especially as the MR was frequently too late to be of great diagnostic utility.

The surveys confirmed that Doppler ultrasound is the main carotid imaging for TIA (95%) not MRA or CTA, perhaps reflecting that the potential for a 'combined brain and carotid' examination (e.g. CT+CTA or MR+MRA) is not practical in most centres. In 59% of stroke services, endarterectomy was performed within one week of the decision to operate. The decreasing delay to surgery is encouraging and in line with guidelines and recent audit reports,[18] but the persistence of delays of up to a month in nearly 40% of patients remains a concern.

The surveys were targeted to clinical leads of stroke prevention services and radiology departments. Response rate for both surveys was 45% which we considered satisfactory for such a survey. The strengths include our use of several mechanisms to prevent sampling bias and increase response rate. We used multiple routes to access all stroke and imaging services clinical leads in the UK and web-based questionnaires for ease of completion. We sent reminders to non-respondents. We reported our findings according to standard methodology (i.e. CHERRIES checklist). We provided web and paper surveys to assist respondents. We based these surveys on several previous surveys of stroke services that achieved high response rates.[11-13]

There were also limitations. The survey was anonymous and voluntary so we are not able to chart service distribution across the UK. We cannot exclude the possibility that some centres submitted two

surveys. To protect the anonymity of the participants we also did not request full demographic details, so were unable to compare respondents with non-respondents. Our findings may, therefore, not apply to all stroke prevention services. Although both internet surveys provided invaluable data to picture current clinical practice, some data were not routinely collected in all centres and respondents were only able to estimate some answers. Not all respondents answered all questions. Even though the 45% response rate for both surveys can be considered satisfactory, we cannot be sure to have captured the full range of performance with respect to current stroke service provision.

There are no other current nation-wide data on clinical services or imaging for stroke prevention in the UK or from other countries. MR usage for stroke is rising rapidly in many countries. For example, MR use rose by 235% in 10 states in the USA from 1999 to 2008,[19] making diagnostic imaging the single fastest growing component of hospital costs rising by 213% from 1999 to 2008 in the USA.[19] MR was used in addition to CT in about half of the patients, a similar pattern to that found in our survey. The use of several imaging tests will increase delays and further impede rapid access to imaging. The increase in use is occurring despite a lack of evidence in a recent systematic review that MR significantly changed management, or any randomised trials, case-control or cohort studies of imaging strategies to justify its increased use.[20]

We suggest that use of expensive resources in TIA/minor stroke, such as brain imaging, could be improved by ensuring that patients only have either CT or MR but not both. Where MR is used, then it should be used as fast as possible (beyond a few days after the TIA/minor stroke is unlikely to detect recent ischaemia and would be a waste of time for that purpose) and diagnostic sequences should include those appropriate to avoid misdiagnosing haemorrhage or TIA/minor stroke mimics; this is particularly critical if MR is used in patients whose presentation is delayed beyond seven days when CT will not differentiate haemorrhage. Further consideration should be given to whether widespread use of nurse triage is the most effective way of dealing with complex TIA/minor stroke mimics which generally require some considerable medical experience to differentiate from true TIA/minor stroke.

AUTHOR CONTRIBUTIONS

JM Wardlaw, M Dennis, P Sandercock conceived the idea for the study and secured funding; M Brazzelli, Z Quayum and JM Wardlaw drafted the survey; D Hadley, K Muir, P McNamee, J DeWilde, M Dennis and P Sandercock tested and edited the survey; M Brazzelli and K Shuler set up the final version of the survey into the survey software; M Dennis, JM Wardlaw, M Brazzelli and J De Wilde disseminated the survey as widely as possible; K Shuler and M Brazzelli downloaded the responses, collated and analysed the results; all authors interpreted the results; M Brazelli and JM Wardlaw drafted the paper; all authors contributed critical comments and edited the manuscript; all authors gave their final approval for submission of the manuscript; JM Wardlaw was the principal investigator and takes full responsibility for the integrity and accuracy of the work. Thus all authors fulfil all three ICMJE criteria for authorship: 1) substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; 3) final approval of the version to be published.

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COMPETING INTERESTS

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the SINAPSE Collaboration. All authors had full unrestricted access to all the study data. The views are those of the authors and not those of the funding agency. There are no other competing interests. JMW takes responsibility for the integrity of the data and the accuracy of the data analysis.

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DATA SHARING

Further data from the survey are available to others upon request. This may provide more details or opportunity for more in depth analysis than were relevant to the present paper. We are happy to provide these data.

References

1 Coull AJ, Lovett JK, Rothwell PM, et al. Population based study of early risk of stroke after transient ischaemic attack or minor stroke: implications for public education and organisation of services. *BMJ* 2004;**328**:326.

2 Giles MF, Rothwell PM. Substantial underestimation of the need for outpatient services for TIA and minor stroke. *Age Ageing* 2007;**36**:676-80.

3 Wasserman J, Perry J, Dowlatshahi D, et al. Stratified, urgent care for transient ischemic attack results in low stroke rates. *Stroke* 2010;**41**:2601-5.

4 Rothwell PM, Giles MF, Chandratheva A, et al. Effect of urgent treatment of transient ischaemic attack and minor stroke on early recurrent stroke (EXPRESS study): a prospective population-based sequential comparison. *Lancet* 2007;**370**:1432-42.

5 Lavallee PC, Meseguer E, Abboud H, et al. A transient ischaemic attack clinic with round-the-clock access (SOS-TIA): feasibility and effects. *Lancet Neurol* 2007;**6**:953-60.

6 Bejot Y, Zeller M, Lorgis L, et al. Secondary prevention in patients with vascular disease. A population based study on the underuse of recommended medications. *J Neurol Neurosurg Psychiatry* 2013;**84**:348-53.

7 Sandercock PAG. Should I start all my ischaemic stroke and TIA patients on a statin, an ACE inhibitor, a diuretic, and aspirin today? *J Neurol Neurosurg Psychiatry* 2003;**74**:1461-4.

8 Department of Health Knowledge & Intelligence Branch. Technical Guidance for the 2011/12 Operating Framework. London: Crown 2011:1-261.

9 Department of Health Payment by Results team. Payment by Results Guidance for 2011-12. London: Crown 2011:1-136.

10 National Institute for Health and Clinical Excellence (NICE). Stroke. The diagnosis and acute management of stroke and transient ischaemic attacks. London: National Institute for Health and Clinical Excellence 2008:1-37.

11 Kane I, Whiteley WN, Sandercock PA, et al. Availability of CT and MR for assessing patients with acute stroke. *Cerebrovasc Dis* 2008;**25**:375-7.

12 Wardlaw JM, Keir SL, Seymour J, et al. What is the best imaging strategy for acute stroke? *Health Technol Assess* 2004;**8**:1-180.

13 Lindley RI, Amayo EO, Marshall J, et al. Hospital services for patients with acute stroke in the United Kingdom: the Stroke Association survey of consultant opinion. *Age Ageing* 1995;**24**:525-32.

14 Eysenbach G. Improving the quality of web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *J Med Internet Res* 2004;**6**:e34.

15 Moreau F, Modi J, Almekhlafi M, et al. Early magnetic resonance imaging in transient ischemic attack and minor stroke: do it or lose it. *Stroke* 2013;**44**:671-4.

16 Dimigen M, Keir S, Dennis M, et al. Long-term visibility of primary intracerebral haemorrhage on MRI. *J Stroke Cerebrovasc Dis* 2004;**13**:104-8.

17 Wardlaw JM, Keir SL, Dennis MS. The impact of delays in computed tomography of the brain on the accuracy of diagnosis and subsequent management in patients with minor stroke. *J Neurol Neurosurg Psychiatry* 2003;**74**:77-81.

18 Intercollegiate Stroke Working Party. National clinical guideline for stroke. London: Royal College of Physicians 2012:1-208.

19 Burke JF, Kerber KA, Iwashyna TJ, et al. Wide variation and rising utilization of stroke magnetic resonance imaging: data from 11 states. *Ann Neurol* 2012;**71**:179-85.

20 Burke JF, Gelb DJ, Quint DJ, et al. The impact of MRI on stroke management and outcomes: a systematic review. *J Eval Clin Pract* Published Online First: 22 November 2012.doi: 10.1111/jep.12011.

FIGURE LEGENDS

FIGURE 1. Proportion of patients attending the stroke prevention clinic who were ultimately diagnosed as having TIA or minor stroke. 102/114 centres answered this question.

FIGURE 2. Proportion of patients suspected of TIA/minor stroke who had CT or MRI as first line brain imaging investigation.

A) Imaging services survey (55/146 responders).

B) Stroke prevention services survey (101/114 responders).

FIGURE 3. Resources needed to expand capacity in fully saturated stroke prevention services. 77/114 responded. Participants were asked to choose all suitable answers.

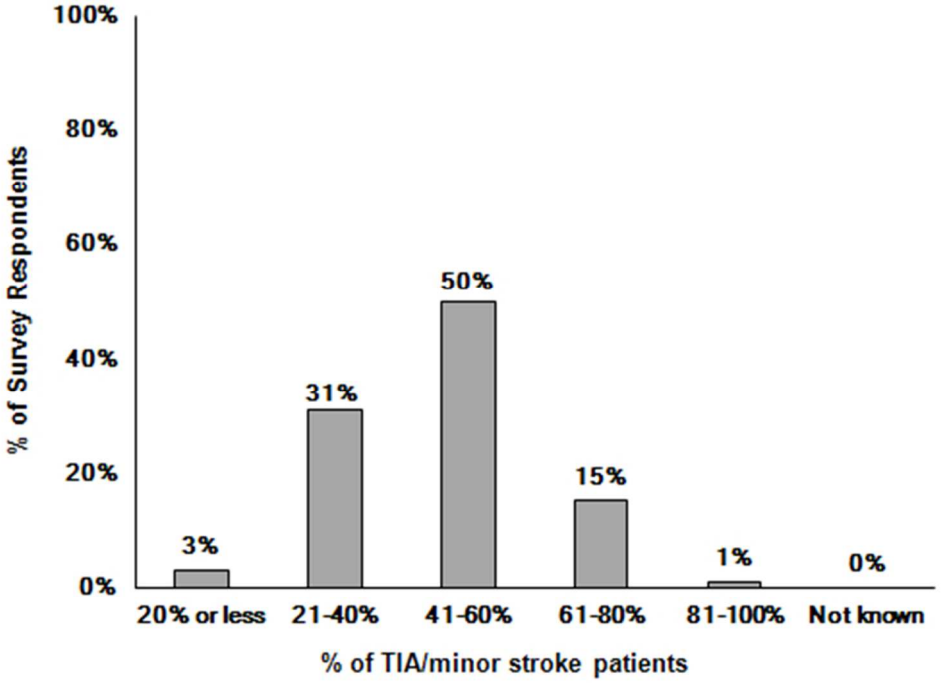


FIGURE 1. Proportion of patients attending the stroke prevention clinic who were ultimately diagnosed as having TIA or minor stroke. 102/114 centres answered this question.
43x31mm (300 x 300 DPI)

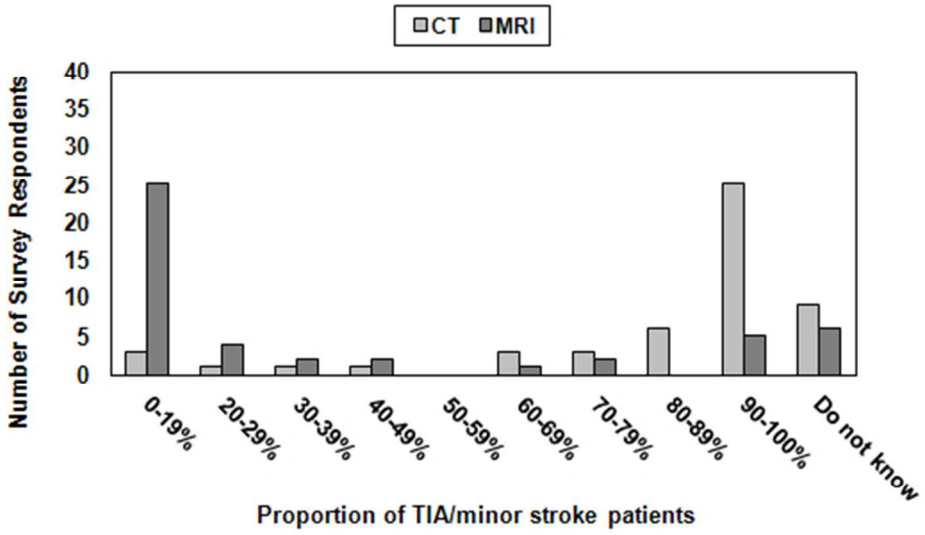


FIGURE 2. Proportion of patients suspected of TIA/minor stroke who had CT or MRI as first line brain imaging investigation.

A) Imaging services survey (55/146 responders).
47x29mm (300 x 300 DPI)

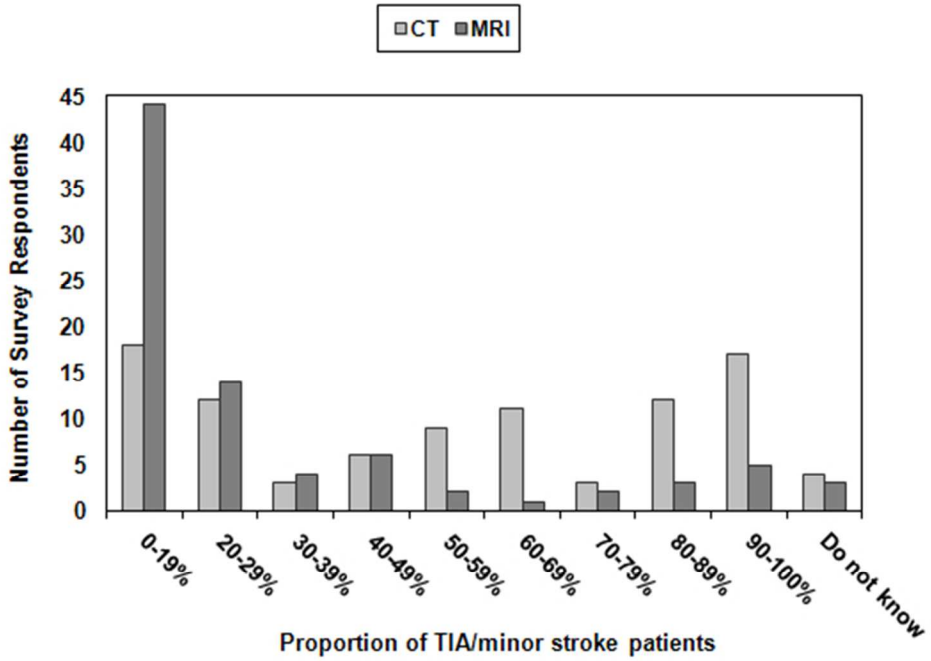


FIGURE 2. Proportion of patients suspected of TIA/minor stroke who had CT or MRI as first line brain imaging investigation.

B) Stroke prevention services survey (101/114 responders).

47x32mm (300 x 300 DPI)

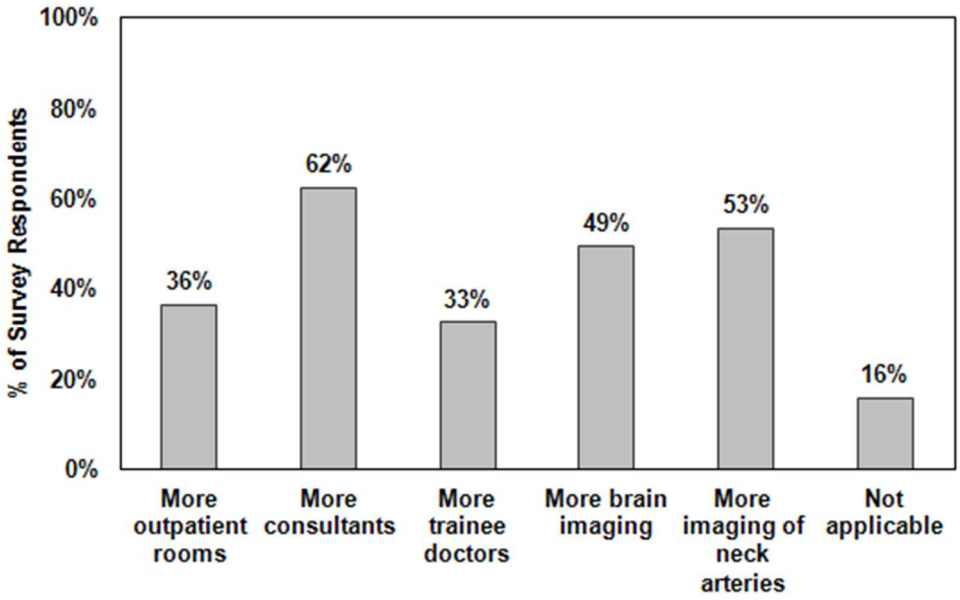


FIGURE 3. Resources needed to expand capacity in fully saturated stroke prevention services. 77/114 responded. Participants were asked to choose all suitable answers.
46x29mm (300 x 300 DPI)

SUPPLEMENTARY MATERIAL

Access to CT and MR brain scanning

The imaging services survey indicated that CT was available for TIA and minor stroke in 94% of departments (136/145 respondents) and accessible out-of-hours in 82%. MRI was available in 99% of imaging departments (133/134 respondents) and in 88% was available for TIA/minor stroke, but actual access to MR varied substantially between inpatients and outpatients and by whether the patient presented in or outside weekday office hours.

In most radiology departments that provided this information (49/56, 87%), inpatients and outpatients were managed differently. On weekdays in normal working hours, inpatients were mostly CT scanned and results provided immediately (Supplementary Table 2); of outpatients, only 59% were scanned with CT immediately or the same day and 32% waited 1-2 weeks. Outside normal weekday hours, inpatients could be CT scanned immediately in 67% of centres but was not available in 19%; outpatients commonly had CT scanning delayed by up to two weeks.

Access to MRI was more restricted, 61% (38/62) providing scanning for TIA/minor stroke on weekdays, during normal working hours without difficulty, but the rest with difficulty or not at all (Supplementary Table 3). During normal weekday hours, inpatients had MRI on the same or next day in 72% of centres (39/54 respondents), or within seven days in 26% of centres (14/54). Outpatients had MRI on the same or next day in 32% of centres (15/47 respondents), within 7-14 days in 55% of centres (26/47), and within one month in 11% of centres (5/47). Outside normal weekday hours, MR was not available or could only be performed with difficulty for TIA/minor stroke patients in most centres (48/58, 83% of centres) and could be performed without any difficulty in only 17% of centres (10/58). Out of hours, inpatients had MRI on the same or next day in 64% of centres (27/42), or within seven days in 29% of centres (12/42); outpatients had MRI on the same or next day in 32% of centres (11/35), within 4-14 days in 54% of centres (19/35) and within one month in 14% (5/35) (Table 3). Results for inpatients in normal weekday hours were generally provided immediately (83% of centres), but outpatients could wait up to seven days (27% of centres); reporting times for patients seen out of hours were longer.

Supplementary Table 1 Patients diagnosed as having TIA or minor stroke who had been prescribed secondary prevention drugs prior to attending the Stroke prevention clinic.

% of TIA minor stroke patients already on secondary prevention	% of stroke services (n/N) who answered affirmatively
20% or less	11% (11/100)
21-40%	8% (8/100)
41-60%	20% (20/100)
61-80%	24% (24/100)
81-100%	29% (29/100)

Supplementary Table 2. Operating hours of CT scanning

Weekly CT scanning (Monday to Friday during normal working hours)

	Inpatients % (n/N)	*Outpatients % (n/N)*
Immediately	23% (13/56)	6% (3/51)
Same day	64% (36/56)	53% (27/51)
Next day	11% (6/56)	8% (4/51)
Within 1 week	2% (1/56)	18% (9/51)
Within 2 weeks	0%	14% (7/51)
Within 1 Month	0%	1% (1/51)

Weekend CT scanning (or outside normal working hours)

	Inpatients % (n/N)	*Outpatients % (n/N)*
Immediately	17% (13/52)	12% (5/43)
Same day	48% (27/52)	26% (11/43)
Next day	33% (1752)	28% (12/43)
Within 1 week	2% (1/52)	23% (10/43)
Within 2 weeks	0%	11% (5/43)
Within 1 Month	0%	0%

Supplementary Table 3. Operating hours of MR scanning among imaging departments

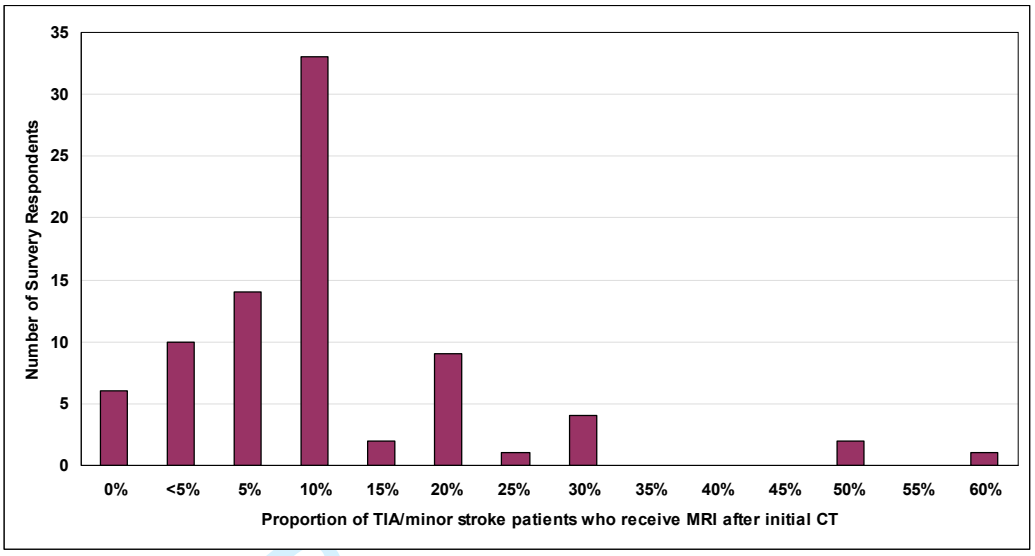
Weekly MR scanning (Monday to Friday during normal working hours)

	Inpatients % (n/N)	*Outpatients % (n/N)*
Immediately	2% (1/54)	2% (1/47)
Same day	35% (19/54)	21% (10/47)
Next day	37% (2054)	11% (5/47)
Within 1 week	20% (14/54)	30% (14/47)
Within 2 weeks	0%	25% (12/47)
Within 1 Month	0%	11% (5/47)

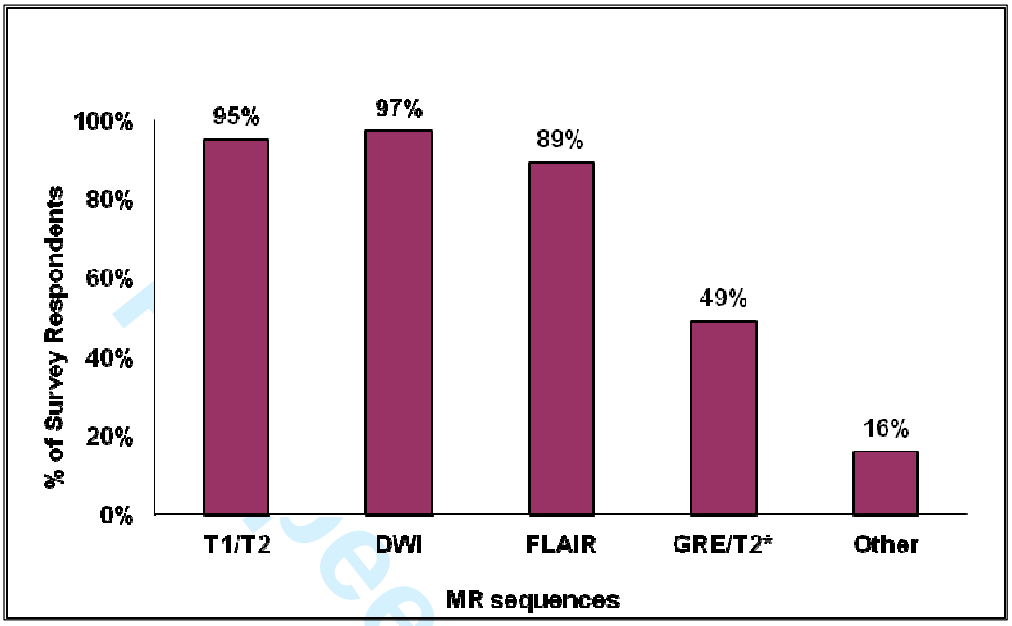
Weekend MR scanning (or outside normal working hours)

	Inpatients % (n/N)	*Outpatients % (n/N)*
Immediately	5% (2/42)	0%
Same day	14% (6/42)	9% (3/35)
Next day	50% (21/42)	23% (8/35)
Within 1 week	29% (12/42)	40% (14/35)
Within 2 weeks	2% (1/42)	14% (5/35)
Within 1 Month	0%	14% (5/35)

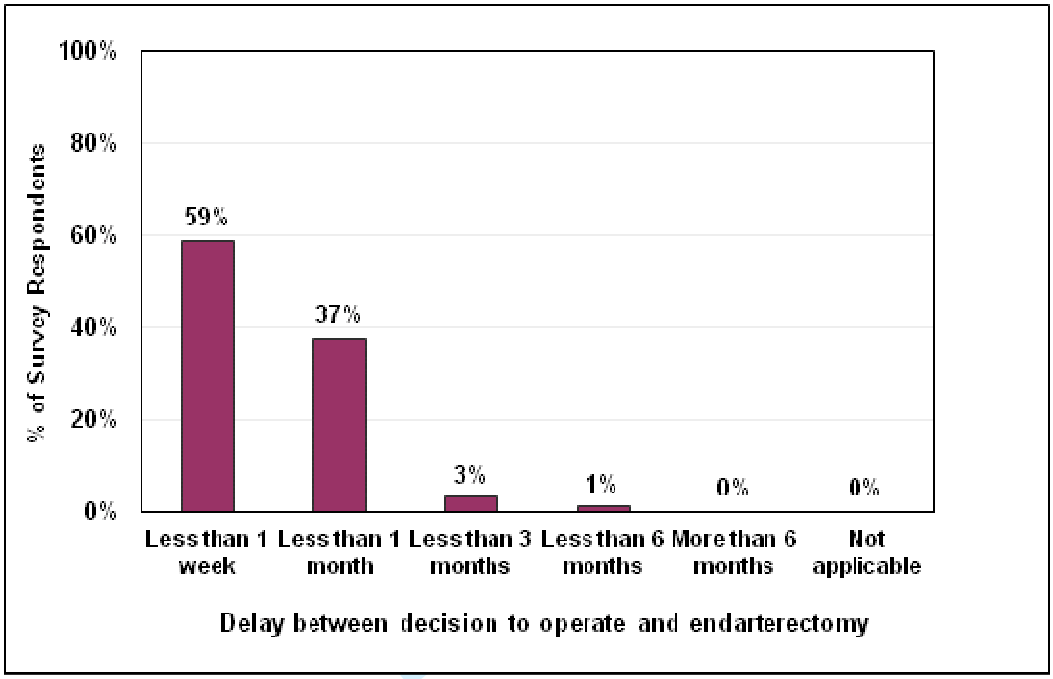
Supplementary Figure 1. Use of MR after CT



Supplementary Figure 2. MR sequences used to assess patients with suspected TIA/minor stroke in the surveyed radiology departments. 128/146 centres answered this question.



Supplementary Figure 3. Delay between the decision to perform endarterectomy and the surgical procedure (99/114 respondents).



Item Category	*Checklist Item*	*YES (the criterion is satisfied)/NO (the criterion is not satisfied)*
Design		
	Describe survey design	YES. The paper provides information on the target population and sample.
IRB (Institutional Review Board) approval and informed consent process		
	IRB approval	Not applicable.
	Informed consent	YES. Participants were informed on the purpose, characteristics and length of the surveys and on the fact that any collected information was treated confidentially. Both surveys included a consent statement to which each participant agreed. The paper refers to the participants' informed consent.
	Data protection	YES. Any information was treated confidentially and anonymity of the participants was preserved. This is stated in the paper.
Development and pre-testing		
	Development and testing	YES. Information on how the surveys were developed and on the initial testing phase is provided in the paper.
Recruitment process and description of the sample having access		

Item Category	*Checklist Item*	*YES (the criterion is satisfied)/NO (the criterion is not satisfied)*
to the questionnaire		
	Open survey versus closed survey	YES. Open surveys. An electronic link was sent to each participant for each questionnaire.
	Contact mode	YES. Methods by which the participants were contacted are clearly described in the paper.
	Advertising the survey	YES. Information on the surveys was disseminated throughout professional bodies' websites and newsletters.
Survey administration		
	Web/E-mail	YES. Information on the type of surveys is reported in the paper. The web links to the two electronic surveys were either e-mail to the participants or posted.
	Context	YES. The paper contains information on how the electronic surveys were developed (survey monkey software) and on the research group who designed them.
	Mandatory/voluntary	YES. Voluntary surveys.
	Incentives	YES. The paper clearly states that no incentives were offered .
	Time/Date	YES. The paper reports the period in which data were collected.
	Randomization of items or	NO. We did not deem necessary to randomize or

Item Category	*Checklist Item*	*YES (the criterion is satisfied)/NO (the criterion is not satisfied)*
	questionnaires	alternate questionnaires.
	Adaptive questioning	YES. According to the answers provided some questions could be skipped.
	Number of Items	YES. Questions were numbered progressively. The number of questions in each questionnaire is reported in the paper.
	Number of screens (pages)	YES. Each page contained a question (in a few cases a sub related question was included in the same page).
	Completeness check	YES. The survey questionnaires had a progress indicator on each page.
	Review step	YES. The participants were able to review and/or change their answers (through a Back button).
Response rates		
	Unique site visitor	NO. We did not formally put in place a mechanism to determine the number of 'unique visitors'. However we asked the participants to provide their demographic information and we used these details to check the relevant centres/hospitals in the UK that replied to the questionnaires.
	View rate (Ratio of unique survey visitors/unique site visitors)	NO.
	Participation rate (Ratio of unique visitors who agreed to participate/unique first survey	NO. We were not in the position to determine a 'recruitment rate'. As for the way the surveys were developed and disseminated, we were not able to

Item Category	*Checklist Item*	*YES (the criterion is satisfied)/NO (the criterion is not satisfied)*
	page visitors)	count the number of people who agreed to participate and divide it by the visitors who visit the first page of the survey.
	Completion rate (Ratio of users who finished the survey/users who agreed to participate)	YES. Information on completion of both questionnaires is described in the paper.
Preventing multiple entries from the same individual		
	Cookies used	Not applicable . Survey Monkey software does not allow for cookies to be used.
	IP check	Not applicable. We were not in the position to prevent users with the same IP address to access the surveys twice.
	Log file analysis	NO. No specific techniques to analyse the log file for identification of multiple entries were used.
	Registration	NO. No specific techniques were used to prevent duplicate entries from the same user. However, demographic information was provided by the participants and we used these details to check for duplicate entries.
Analysis		
	Handling of incomplete questionnaires	YES. Completed and partially completed questionnaires were analysed.

Item Category	*Checklist Item*	*YES (the criterion is satisfied)/NO (the criterion is not satisfied)*
	Questionnaires submitted with an atypical timestamp	Not applicable. We were not in the position to measure the time people needed to fill in the questionnaires and exclude those that were completed too soon or within a pre-determined timeframe.
	Statistical correction	NO. No specific methods were used to adjust for the non-representative sample.

Clinical and imaging services for TIA and minor stroke– results of two surveys of practice across the UK

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Title: Clinical and imaging services for TIA and minor stroke– results of two surveys of practice across the UK

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ARTICLE SUMMARY

Article focus

- Is the current provision of stroke prevention clinical services adequate to meet the volume of work in the UK?
- Is access to brain and carotid imaging adequate to meet the demand and is imaging being used efficiently?
- Who is providing these services?

Key Messages

- Most responding centres had some form of rapid access stroke prevention clinic.
- Front line assessment was by nurses in nearly a third of clinics, but about half of patients have a TIA mimic which requires medical expertise for diagnosis.
- There was efficient use CT brain and carotid ultrasound imaging, but less good access to MR brain imaging and this was often used incorrectly or inefficiently.

Strengths and limitations

- The survey covered the whole of the UK and achieved a 45% response rate.
- Clinical and imaging services responses were highly concurrent.
- Services may be much worse in areas that did not respond.

ABSTRACT

Objectives

Transient ischaemic attack (TIA) is a medical emergency requiring rapid access to effective, organised, stroke prevention. There are about 90,000 TIAs per year in the UK. We assessed whether stroke prevention services in the UK meet Government targets.

Design

Cross-sectional survey.

Setting

All UK clinical and imaging stroke prevention services.

Intervention

Electronic structured survey delivered over the web with automatic recording of responses into a database. Reminders to non respondents. The survey sought information on clinic frequency, staff, casemix, details of brain and carotid artery imaging, medical and surgical treatments.

Results

114 stroke clinical and 146 imaging surveys were completed (both response rates 45%). Stroke prevention services were available in most (97%) centres but only 31% operated 7 days per week. Half of clinic referrals were TIA mimics, most patients (75%) were prescribed secondary prevention prior to clinic referral, and nurses performed the medical assessment in 28% of centres. CT was the most common and fastest first-line investigation; MR, used in 51% of centres, mostly after CT, was delayed up to two weeks in 26%; 51% of centres omitted blood-sensitive (GRE/T2*) MR sequences. Carotid imaging was with ultrasound in 95% of centres and 59% performed endarterectomy within one week of deciding to operate.

Conclusions

Stroke prevention services are widely available in the UK. Delays to MRI, its use in addition to CT while omitting key sequences to diagnose haemorrhage, limit the potential benefit of MRI in stroke prevention, but inflate costs. Assessing TIA mimics requires clinical neurology expertise yet nurses run 28% of clinics. Further improvements are still required for optimal stroke prevention.

BACKGROUND

TIA and minor stroke are medical emergencies. In the UK there are 80,000 to 90,000 TIAs and minor strokes every year.[1, 2] The benefit of medical or surgical treatment to prevent recurrent stroke after TIA is greatest if given as early as possible;[3-5] the benefit falls rapidly with increasing delay.[6, 7] Patients with TIA and minor stroke need a rapid, comprehensive assessment and active management to reduce the short and long term risks of recurrent stroke. Establishing an accurate diagnosis and delivering effective stroke prevention is challenging and requires organised stroke services. NHS Improvement in England introduced tariffs to encourage the establishment of stroke prevention services which meet key performance criteria; there are supplementary tariffs for achieving optimum management of high risk TIA patients by rapid triage of patients with ABCD2 score ≥4 including use of MRI (additional amount payable £450 to £634 per patient in 2012, equivalent to $670-945 US).[8, 9] We surveyed UK clinical and imaging secondary stroke prevention services to determine their performance against recent guidelines.[10]

METHODS

We devised two electronic survey questionnaires, one for clinical stroke prevention services and one for imaging services using the online survey software 'SurveyMonkey' (www.surveymonkey.com). These were informed by previous questionnaires sent to stroke services which achieved high response rates.[11-13] We used a 'closed', 'structured' response format. Both questionnaires provided information on the rationale and purpose of the study, including details of the research team, and incorporated best research practice issues such as confidentiality and informed consent.

Following pilot testing, the agreed versions of the survey questionnaires (available on request) contained detailed questions addressing the current provision of stroke prevention services (56 questions) and imaging services (47 questions) focusing on the volume of work, capacity, professionals involved, type and timing of brain and carotid imaging (within or outside normal office hours, for inpatients or outpatients), and carotid endarterectomy rates. We considered eligible participants to be all clinical leads of UK stroke services and radiology departments.

We offered no incentives to participate in the surveys. The responses were completely anonymous and completion was voluntary hence approval of Ethics Committees was not required. We sent letters of invitation explaining the objectives and providing links to access the questionnaires online in April 2011 by email or post, via multiple routes, to all UK stroke clinical leads and Radiology Directorates, including: stroke leads of all 15 NHS Boards in Scotland through the Scottish Stroke Care Audit; the 27 stroke networks (with three to nine clinical sites within each network) through NHS Improvement following contact with the Department of Health; to Stroke Leads in Trust Hospitals through the Royal College of Physicians Sentinel Stroke Audit database (200 hospitals in 158 Trusts in England, Wales and Northern Ireland); to Radiology Directorate Leads in England through NHS Improvement and the Magnetic Resonance National Evaluation Team (MagNET) database; all 12 Scottish Clinical Directors of Radiology through the Diagnostic Imaging Clinical Network; and to clinical and imaging stroke services in Wales through the Stroke Collaborative. The surveys went to 171 Acute Trusts, 129 Foundation Trusts, seven Welsh Trusts, hospitals in the 15 NHS Boards in Scotland and hospitals in Northern Ireland. We estimated from the contact lists that there were in total 253 Stroke Services sites and 342 Radiology Departments to contact although there is no central list of all of this information in one place. Our questionnaire included questions about stroke patients that were assessed at the hospital but in other clinics, eg in acute receiving units or general medicine, with the intention of obtaining information on all stroke prevention pathways. Details of the surveys and the online links were also disseminated through the Royal College of Physicians website and advertised through the NHS Improvement Stroke and Radiology newsletters. Reminder messages were sent to non-respondents in June 2011.

Data management and analysis

The results of both internet surveys were reported according to the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) statement.[14]

Surveys results were generated using SurveyMonkey software and entered into an Excel spreadsheet. We expressed the clinical leads' answers as proportions, medians, or means. Not all respondents answered all the questions, therefore the percentages reported are of the actual numbers of respondents. To calculate the response rate, we divided the number of clinical leads to whom we initially sent the invitation to participate by the number of participants who actually completed the online questionnaires. However, as both surveys were also disseminated and advertised through professional body websites and newsletters, it was not feasible to calculate the exact number of all potential respondents contacted. The surveys were completed anonymously therefore it was not possible to associate services with geographical location.

RESULTS

One hundred and fourteen Stroke Service surveys and 146 Imaging Service surveys were partially or fully completed, a response rate of 45% for each.

Stroke prevention clinics. Among the 114 respondents, the mean catchment population was 400,000 people (median 300,000); 97% indicated that their hospital had a specialist stroke prevention clinic. The service was run at least once a week in 99%; every weekday in 47%; and every day in 31%. Most centres (86%, 88/102 respondents) saw between one and five new patients per clinic. In half of the clinics (51/102 respondents), the estimated proportion of patients ultimately diagnosed as TIA/minor stroke mimics was 41-60%; in 31% of centres it was between 60-79%. In only 16% of centres did definite TIA/minor strokes make up the majority (61-100%) of attendees (figure 1).

Thirty-five percent of the TIA/minor stroke patients were seen by the stroke prevention clinic within 24 hours, 25% between 2-3 days, and about 20% within one week of their symptoms. Thirteen percent of centres indicated that patients considered at high risk according to the ABCD2 risk prediction score were seen within 24 hours of referral and low risk patients within seven days.

Most stroke prevention clinics were run by consultants (stroke physicians; neurologists; geriatricians). However, the main medical assessment/triaging was undertaken by nurses in 28% of centres. The final diagnosis was established either with input from, or by a consultant in 71% of centres.

In most centres, most patients seen at the specialist stroke prevention service had already been prescribed secondary prevention drugs (e.g. aspirin; statins) for their recent suspected TIA/minor stroke by their referring doctor (supplementary table 1).

Brain imaging of TIA/minor stroke

The stroke services survey showed that CT was routinely used as the main brain imaging modality in 84% (98/114 respondents) and that MRI was used in only 51% of centres for stroke prevention. This concurred very closely with the imaging services survey which showed that CT was the main modality in most departments (86%, 49/57 respondents). Details of access to CT and MR are provided in supplementary Tables 2 and 3. The stroke prevention and imaging surveys both also showed that most patients were having CT as first line test (figure 2a and figure 2b). The proportion of TIA/minor stroke patients for whom a subsequent MRI was requested after an initial CT varied considerably (range 0%-60%) (supplementary figure 1), the waiting time for MR after CT being one month in about half of centres (47%). The results of brain imaging were returned to the stroke service on the day of scanning in 66% of centres; for 22%, however, it took more than 2 days. In most centres (76%), positive brain imaging results (e.g. haemorrhage) were provided to the stroke prevention clinic immediately.

The routine MR sequences used for TIA/minor stroke were primarily focused on detecting ischaemia: T1-weighted or T2-weighted, diffusion-weighted imaging (DWI), and Fluid Attenuated Inversion Recovery (FLAIR) sequences. Fewer than half of the departments (49%) performed sequences that are sensitive to haemorrhage (e.g. gradient echo, GRE/T2*, supplementary figure 2). Some departments (18%) used only DWI and T2-weighted sequences routinely, thus limiting the chance of detecting either cerebral haemorrhage or non-vascular brain lesions that mimic stroke/TIA.

Carotid artery imaging and endarterectomy

Carotid artery imaging most frequently took place the day of the clinic (47%, 47/100 respondents). Doppler ultrasound (DUS) was the first line carotid/vertebral imaging in most centres (95%). Most centres (80%) provided the results of carotid artery imaging on the same day, and most centres (86%; 85/99 respondents) provided important positive results immediately. A repeat DUS (19%), or CTA (60%) or contrast MRA (41% of centres) were used as confirmatory tests prior to referral for endarterectomy.

The time between the decision to perform a carotid endarterectomy and the actual surgical procedure was less than one week in 59% of centres and between one and three weeks in approximately 37% of centres (supplementary figure 3). No stroke service performed endarterectomy more than six months after the decision to operate.

Workload volume and capacity

During 2010, on average 4,905 CT brain scans were performed per radiology department (range 20-48,346; median 2,500), 18% were conducted out-of-hours but with considerable variation. On average 686 CT brain scans were for patients with suspected TIA/minor stroke (range 0-5,000 scans; median 200 scans), i.e. about 14% of the total workload. On average, 9% of these CT scans were performed out-of-hours (range 0-60% scans; median 2% scans).

During 2010, on average 2,888 brain MR images were performed per radiology department (range 20-24,391 scans; median 1,530 scans), only 3% of MR scans were conducted out-of-hours (most performed no MR brain imaging out-of-hours). On average, 258 MR brain scans were conducted on patients suspected of TIA/minor stroke (range 0-1,200 scans; median 100 scans), ie about 9% of the total workload.

Forty-three percent of the stroke prevention centres indicated that they had spare capacity to see further patients. Responses varied as to what extra facilities were required to expand the current stroke service (figure 3), 'more consultants' being the most frequent, but 'more carotid imaging' was required in 53%. When 'more brain imaging' was chosen, all respondents opted for more MRI (38/38 respondents) rather than CT (14/38).

DISCUSSION

These simultaneous surveys of stroke prevention clinics and imaging services indicate that the necessary components of stroke prevention services are widely available in the UK, but their structure and organisation vary considerably and an important proportion of practice remains suboptimal (Table 1). In most centres (78%), specialist stroke prevention services operate every weekday with on average five new patients attending each clinic yet only 60% of patients were seen within one week of their event. Additionally, over half the case-load are patients with a final diagnosis of a non TIA/minor stroke 'mimic'. Specialist medical knowledge is required for accurate diagnosis and appropriate medical management of this very heterogeneous case-mix, yet in a quarter of clinics, the main assessment is by nurses.

Table 1. Key findings.

- Nurses provide the primary assessment and diagnosis in nearly a third of clinics;
- 50% of patients attending these clinics have TIA/minor stroke mimic;
- Most patients (75%) have already started secondary prevention treatment before attending the clinic;
- CT for TIA and minor stroke is widely available (94%), is the first line test in the vast majority of centres, and is routinely used in 82%;
- MR is available for TIA and minor stroke patients in 88% of centres but in about half of those it is after an initial CT scan
- There are long delays to MR imaging;
- The key MR sequence needed to diagnose haemorrhage is omitted in more than half of centres, reducing the value of MR;
- Ultrasound is the primary carotid imaging test in 95% of centres;
- There is limited capacity to undertake more imaging although about 40% of stroke services

indicated that they had capacity to see more patients; however the main barrier to seeing more patients was the limited availability of MR.

The consistency between the clinical services' and imaging departments' responses to the question about first line imaging method is striking (figure 2a and figure 2b). Both CT and MR are widely available but access to CT is more rapid and more complete than for MR, particularly outside normal office hours and for outpatients (Supplementary tables 2 and 3). MR was commonly performed in addition to and after CT – possibly somewhat inappropriately since the diagnostic yield from MR for ischaemic lesions on diffusion imaging declines rapidly with time after the event.[15] The survey did not include a question on why MR was performed in addition to CT (or vice versa) therefore we are not able to say why this practice was so common. Furthermore, in more than half the centres, the key MR sequence required to identify haemorrhage accurately (i.e. GRE/T2* or equivalent) was omitted (Supplementary figure 2),[16] increasing the risk that haemorrhages would be misdiagnosed as ischaemic events[17] (one of the two main reasons for brain imaging in TIA/minor stroke) leading to these patients receiving potentially inappropriate antithrombotic or anticoagulant treatment or even offered inappropriate carotid endarterectomy. Some centres that only use DWI and T2 are also likely to miss some stroke/TIA mimics that could otherwise be diagnosed with MR (the other of the two main reasons for brain imaging in TIA/minor stroke). Most patients had already been started on secondary prevention by their GPs before they reached the clinic (supplementary table 1), further questioning the value of MR performed in addition to CT, especially as the MR was frequently too late to be of great diagnostic utility.

The surveys confirmed that Doppler ultrasound is the main carotid imaging for TIA (95%) not MRA or CTA, perhaps reflecting that the potential for a 'combined brain and carotid' examination (e.g. CT+CTA or MR+MRA) is not practical in most centres. In 59% of stroke services, endarterectomy was performed within one week of the decision to operate. The decreasing delay to surgery is encouraging and in line with guidelines and recent audit reports,[18] but the persistence of delays of up to a month in nearly 40% of patients remains a concern.

The surveys were targeted to clinical leads of stroke prevention services and radiology departments. Response rate for both surveys was 45% which we considered satisfactory for such a survey in view of the large number of departments surveyed, the busy workload of service leads and their many administrative tasks. The response rates in three previous surveys about stroke services were higher but these took place amongst much smaller catchment groups where many of the respondents knew the surveyors personally and were highly motivated about the topic of the survey.[11-13] The present survey went to a substantially larger number of sites across the whole of the United Kingdom and inevitably could not achieve the same personal touch. The strengths include our use of several mechanisms to prevent sampling bias and increase response rate. We used multiple routes to access all stroke and imaging services clinical leads in the UK and web-based questionnaires for ease of completion. We sent reminders to non-respondents. We reported our findings according to standard methodology (i.e. CHERRIES checklist). We provided web and paper surveys to assist respondents. We based these surveys on several previous surveys of stroke services that achieved high response rates.[11-13]

There were also limitations. The survey was anonymous and voluntary so we are not able to chart service distribution across the UK. We cannot exclude the possibility that some centres submitted two surveys. To protect the anonymity of the participants we also did not request full demographic details, so were unable to compare respondents with non-respondents. Our findings may, therefore, not apply to all stroke prevention services. Although both internet surveys provided invaluable data to picture current clinical practice, some data were not routinely collected in all centres and respondents were only able to estimate some answers. Not all respondents answered all questions. Even though the 45% response rate for both surveys can be considered satisfactory, we cannot be sure to have captured the full range of performance with respect to current stroke service provision.

There are no other current nation-wide data on clinical services or imaging for stroke prevention in the UK or from other countries. MR usage for stroke is rising rapidly in many countries. For example,

MR use rose by 235% in 10 states in the USA from 1999 to 2008,[19] making diagnostic imaging the single fastest growing component of hospital costs rising by 213% from 1999 to 2008 in the USA.[19] MR was used in addition to CT in about half of the patients, a similar pattern to that found in our survey. The use of several imaging tests will increase delays and further impede rapid access to imaging. The increase in use is occurring despite a lack of evidence in a recent systematic review that MR significantly changed management, or any randomised trials, case-control or cohort studies of imaging strategies to justify its increased use.[20]

We suggest that use of expensive resources in TIA/minor stroke, such as brain imaging, could be improved by ensuring that patients only have either CT or MR but not both. Where MR is used, then it should be used as fast as possible (beyond a few days after the TIA/minor stroke is unlikely to detect recent ischaemia and would be a waste of time for that purpose) and diagnostic sequences should include those appropriate to avoid misdiagnosing haemorrhage or TIA/minor stroke mimics; this is particularly critical if MR is used in patients whose presentation is delayed beyond seven days when CT will not differentiate haemorrhage. Further consideration should be given to whether widespread use of nurse triage is the most effective way of dealing with complex TIA/minor stroke mimics which generally require some considerable medical experience to differentiate from true TIA/minor stroke.

AUTHOR CONTRIBUTIONS

JM Wardlaw, M Dennis, P Sandercock conceived the idea for the study and secured funding; M Brazzelli, Z Quayum and JM Wardlaw drafted the survey; D Hadley, K Muir, P McNamee, J DeWilde, M Dennis and P Sandercock tested and edited the survey; M Brazzelli and K Shuler set up the final version of the survey into the survey software; M Dennis, JM Wardlaw, M Brazzelli and J De Wilde disseminated the survey as widely as possible; K Shuler and M Brazzelli downloaded the responses, collated and analysed the results; all authors interpreted the results; M Brazelli and JM Wardlaw drafted the paper; all authors contributed critical comments and edited the manuscript; all authors gave their final approval for submission of the manuscript; JM Wardlaw was the principal investigator and takes full responsibility for the integrity and accuracy of the work. Thus all authors fulfil all three ICMJE criteria for authorship: 1) substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; 3) final approval of the version to be published.

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COMPETING INTERESTS

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DATA SHARING

Extra data can be accessed via the Dryad data repository at http://datadryad.org/ with the doi:10.5061/dryad.3nc25.

References

1 Coull AJ, Lovett JK, Rothwell PM, et al. Population based study of early risk of stroke after transient ischaemic attack or minor stroke: implications for public education and organisation of services. *BMJ* 2004;**328**:326.

2 Giles MF, Rothwell PM. Substantial underestimation of the need for outpatient services for TIA and minor stroke. *Age Ageing* 2007;**36**:676-80.

3 Wasserman J, Perry J, Dowlatshahi D, et al. Stratified, urgent care for transient ischemic attack results in low stroke rates. *Stroke* 2010;**41**:2601-5.

4 Rothwell PM, Giles MF, Chandratheva A, et al. Effect of urgent treatment of transient ischaemic attack and minor stroke on early recurrent stroke (EXPRESS study): a prospective population-based sequential comparison. *Lancet* 2007;**370**:1432-42.

5 Lavallee PC, Meseguer E, Abboud H, et al. A transient ischaemic attack clinic with round-the-clock access (SOS-TIA): feasibility and effects. *Lancet Neurol* 2007;**6**:953-60.

6 Bejot Y, Zeller M, Lorgis L, et al. Secondary prevention in patients with vascular disease. A population based study on the underuse of recommended medications. *J Neurol Neurosurg Psychiatry* 2013;**84**:348-53.

7 Sandercock PAG. Should I start all my ischaemic stroke and TIA patients on a statin, an ACE inhibitor, a diuretic, and aspirin today? *J Neurol Neurosurg Psychiatry* 2003;**74**:1461-4.

8 Department of Health Knowledge & Intelligence Branch. Technical Guidance for the 2011/12 Operating Framework. London: Crown 2011:1-261.

9 Department of Health Payment by Results team. Payment by Results Guidance for 2011-12. London: Crown 2011:1-136.

10 National Institute for Health and Clinical Excellence (NICE). Stroke. The diagnosis and acute management of stroke and transient ischaemic attacks. London: National Institute for Health and Clinical Excellence 2008:1-37.

11 Kane I, Whiteley WN, Sandercock PA, et al. Availability of CT and MR for assessing patients with acute stroke. *Cerebrovasc Dis* 2008;**25**:375-7.

12 Wardlaw JM, Keir SL, Seymour J, et al. What is the best imaging strategy for acute stroke? *Health Technol Assess* 2004;**8**:1-180.

13 Lindley RI, Amayo EO, Marshall J, et al. Hospital services for patients with acute stroke in the United Kingdom: the Stroke Association survey of consultant opinion. *Age Ageing* 1995;**24**:525-32.

14 Eysenbach G. Improving the quality of web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *J Med Internet Res* 2004;**6**:e34.

15 Moreau F, Modi J, Almekhlafi M, et al. Early magnetic resonance imaging in transient ischemic attack and minor stroke: do it or lose it. *Stroke* 2013;**44**:671-4.

16 Dimigen M, Keir S, Dennis M, et al. Long-term visibility of primary intracerebral haemorrhage on MRI. *J Stroke Cerebrovasc Dis* 2004;**13**:104-8.

17 Wardlaw JM, Keir SL, Dennis MS. The impact of delays in computed tomography of the brain on the accuracy of diagnosis and subsequent management in patients with minor stroke. *J Neurol Neurosurg Psychiatry* 2003;**74**:77-81.

18 Intercollegiate Stroke Working Party. National clinical guideline for stroke. London: Royal College of Physicians 2012:1-208.

19 Burke JF, Kerber KA, Iwashyna TJ, et al. Wide variation and rising utilization of stroke magnetic resonance imaging: data from 11 states. *Ann Neurol* 2012;**71**:179-85.

20 Burke JF, Gelb DJ, Quint DJ, et al. The impact of MRI on stroke management and outcomes: a systematic review. *J Eval Clin Pract* 2012;**doi: 10.1111/jep.12011**.

FIGURE LEGENDS

FIGURE 1. Proportion of patients attending the stroke prevention clinic who were ultimately diagnosed as having TIA or minor stroke. 102/114 centres answered this question.

FIGURE 2. Proportion of patients suspected of TIA/minor stroke who had CT or MRI as first line brain imaging investigation.

A) Imaging services survey (55/146 responders).

B) Stroke prevention services survey (101/114 responders).

FIGURE 3. Resources needed to expand capacity in fully saturated stroke prevention services. 77/114 responded. Participants were asked to choose all suitable answers.

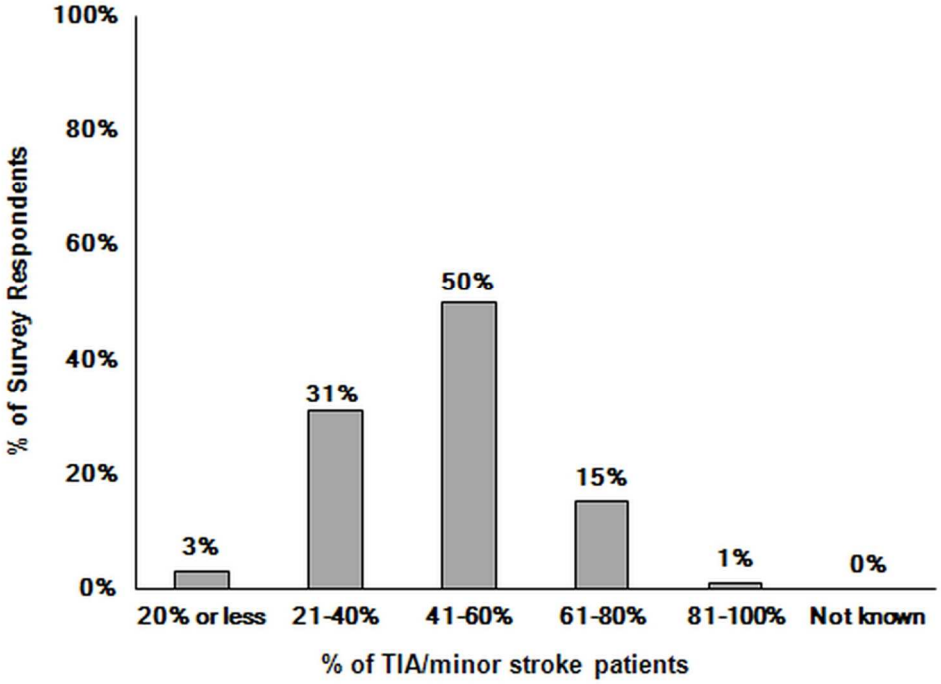

FIGURE 1. Proportion of patients attending the stroke prevention clinic who were ultimately diagnosed as having TIA or minor stroke. 102/114 centres answered this question.
124x90mm (300 x 300 DPI)

Title: Clinical and imaging services for TIA and minor stroke– results of two surveys of practice across the UK

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ABSTRACT

Objectives

Transient ischaemic attack (TIA) is a medical emergency requiring rapid access to effective, organised, stroke prevention. There are about 90,000 TIAs per year in the UK. We assessed whether stroke prevention services in the UK meet Government targets.

Design

Cross-sectional survey.

Setting

All UK clinical and imaging stroke prevention services.

Intervention

Electronic structured survey delivered over the web with automatic recording of responses into a database. Reminders to non respondents. The survey sought information on clinic frequency, staff, casemix, details of brain and carotid artery imaging, medical and surgical treatments.

Results

114 stroke clinical and 146 imaging surveys were completed (both response rates 45%). Stroke prevention services were available in most (97%) centres but only 31% operated 7 days per week. Half of clinic referrals were TIA mimics, most patients (75%) were prescribed secondary prevention prior to clinic referral, and nurses performed the medical assessment in 28% of centres. CT was the most common and fastest first-line investigation; MR, used in 51% of centres, mostly after CT, was delayed up to two weeks in 26%; 51% of centres omitted blood-sensitive (GRE/T2*) MR sequences. Carotid imaging was with ultrasound in 95% of centres and 59% performed endarterectomy within one week of deciding to operate.

Conclusions

Stroke prevention services are widely available in the UK. Delays to MRI, its use in addition to CT while omitting key sequences to diagnose haemorrhage, limit the potential benefit of MRI in stroke prevention, but inflate costs. Assessing TIA mimics requires clinical neurology expertise yet nurses run 28% of clinics. Further improvements are still required for optimal stroke prevention.

BACKGROUND

TIA and minor stroke are medical emergencies. In the UK there are 80,000 to 90,000 TIAs and minor strokes every year.[1, 2] The benefit of medical or surgical treatment to prevent recurrent stroke after TIA is greatest if given as early as possible;[3-5] the benefit falls rapidly with increasing delay.[6, 7] Patients with TIA and minor stroke need a rapid, comprehensive assessment and active management to reduce the short and long term risks of recurrent stroke. Establishing an accurate diagnosis and delivering effective stroke prevention is challenging and requires organised stroke services. NHS Improvement in England introduced tariffs to encourage the establishment of stroke prevention services which meet key performance criteria; there are supplementary tariffs for achieving optimum management of high risk TIA patients by rapid triage of patients with ABCD2 score ≥4, including use of MRI (additional amount payable £450 to £634 per patient in 2012, equivalent to $670-945 US).[8, 9] We surveyed UK clinical and imaging secondary stroke prevention services to determine their performance against recent guidelines.[10]

METHODS

We devised two electronic survey questionnaires, one for clinical stroke prevention services and one for imaging services using the online survey software 'SurveyMonkey' (www.surveymonkey.com). These were informed by previous questionnaires sent to stroke services which achieved high response rates.[11-13] We used a 'closed', 'structured' response format. Both questionnaires provided information on the rationale and purpose of the study, including details of the research team, and incorporated best research practice issues such as confidentiality and informed consent.

Following pilot testing, the agreed versions of the survey questionnaires (available on request) contained detailed questions addressing the current provision of stroke prevention services (56 questions) and imaging services (47 questions) focusing on the volume of work, capacity, professionals involved, type and timing of brain and carotid imaging (within or outside normal office hours, for inpatients or outpatients), and carotid endarterectomy rates. We considered eligible participants to be all clinical leads of UK stroke services and radiology departments.

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We offered no incentives to participate in the surveys. The responses were completely anonymous and completion was voluntary hence approval of Ethics Committees was not required. We sent letters of invitation explaining the objectives and providing links to access the questionnaires online in April 2011 by email or post, via multiple routes, to all UK stroke clinical leads and Radiology Directorates, including: stroke leads of all 15 NHS Boards in Scotland through the Scottish Stroke Care Audit; the 27 stroke networks (with three to nine clinical sites within each network) through NHS Improvement following contact with the Department of Health; to Stroke Leads in Trust Hospitals through the Royal College of Physicians Sentinel Stroke Audit database (200 hospitals in 158 Trusts in England, Wales and Northern Ireland); to Radiology Directorate Leads in England through NHS Improvement and the Magnetic ~~resonance~~ Resonance National Evaluation Team (MagNET) database; all 12 Scottish Clinical Directors of Radiology through the Diagnostic Imaging Clinical Network; and to clinical and imaging stroke services in Wales through the Stroke Collaborative. The surveys went to 171 Acute Trusts, 129 Foundation Trusts, ~~and~~ seven Welsh Trusts, ~~and~~ hospitals in the 15 NHS Boards in Scotland and hospitals in Northern Ireland. We estimated from the contact lists that there were in total 253 Stroke Services sites and 342 Radiology Departments to contact although there is no central list of all of this information in one place. Our questionnaire included questions about stroke patients that were assessed at the hospital but in other clinics, eg in acute receiving units or general medicine, with the intention of obtaining information on all stroke prevention pathways. Details of the surveys and the online links were also disseminated through the Royal College of Physicians website and advertised through the NHS Improvement Stroke and Radiology newsletters. Reminder messages were sent to non-respondents in June 2011.

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Data management and analysis

The results of both internet surveys were reported according to the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) statement.[14]

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Surveys results were generated using SurveyMonkey software and entered into an Excel spreadsheet. We expressed the clinical leads' answers as proportions, medians, or means. Not all respondents answered all the questions, therefore the percentages reported are of the actual numbers of respondents. To calculate the response rate, we divided the number of clinical leads to whom we initially sent the invitation to participate by the number of participants who actually completed the online questionnaires. However, as both surveys were also disseminated and advertised through professional body websites and newsletters, it was not feasible to calculate the exact number of all potential respondents contacted. The surveys were completed anonymously therefore it was not possible to associate services with geographical location.

RESULTS

One hundred and fourteen Stroke Service surveys and 146 Imaging Service surveys were partially or fully completed, a response rate of 45% for each.

Stroke prevention clinics. Among the 114 respondents, the mean catchment population was 400,000 people (median 300,000); 97% indicated that their hospital had a specialist stroke prevention clinic. The service was run at least once a week in 99%; every weekday in 47%; and every day in 31%. Most centres (86%, 88/102 respondents) saw between one and five new patients per clinic. In half of the clinics (51/102 respondents), the estimated proportion of patients ultimately diagnosed as TIA/minor stroke mimics was 41-60%; in 31% of centres it was between 60-79%. In only 16% of centres did definite TIA/minor strokes make up the majority (61-100%) of attendees (figure 1).

Thirty-five percent of the TIA/minor stroke patients were seen by the stroke prevention clinic within 24 hours, 25% between 2-3 days, and about 20% within one week of their symptoms. Thirteen percent of centres indicated that patients considered at high risk according to the ABCD2 risk prediction score were seen within 24 hours of referral and low risk patients within seven days.

Most stroke prevention clinics were run by consultants (stroke physicians; neurologists; geriatricians). However, the main medical assessment/triaging was undertaken by nurses in 28% of centres. The final diagnosis was established either with input from, or by a consultant in 71% of centres.

In most centres, most patients seen at the specialist stroke prevention service had already been prescribed secondary prevention drugs (e.g. aspirin; statins) for their recent suspected TIA/minor stroke by their referring doctor (supplementary table 1).

Brain imaging of TIA/minor stroke

The stroke services survey showed that CT was routinely used as the main brain imaging modality in 84% (98/114 respondents) and that MRI was used in only 51% of centres for stroke prevention. This concurred very closely with the imaging services survey which showed that CT was the main modality in most departments (86%, 49/57 respondents). Details of access to CT and MR are provided in supplementary Tables 2 and 3. The stroke prevention and imaging surveys both also showed that most patients were having CT as first line test (figure 2a and figure 2b). The proportion of TIA/minor stroke patients for whom a subsequent MRI was requested after an initial CT varied considerably (range 0%-60%) (supplementary figure 1), the waiting time for MR after CT being one month in about half of centres (47%). The results of brain imaging were returned to the stroke service on the day of scanning in 66% of centres; for 22%, however, it took more than 2 days. In most centres (76%), positive brain imaging results (e.g. haemorrhage) were provided to the stroke prevention clinic immediately.

The routine MR sequences used for TIA/minor stroke were primarily focused on detecting ischaemia: T1-weighted or T2-weighted, diffusion-weighted imaging (DWI), and Fluid Attenuated Inversion Recovery (FLAIR) sequences. Fewer than half of the departments (49%) performed sequences that are sensitive to haemorrhage (e.g. gradient echo, GRE/T2*, supplementary figure 2). Some departments (18%) used only DWI and T2-weighted sequences routinely, thus limiting the chance of detecting either cerebral haemorrhage or non-vascular brain lesions that mimic stroke/TIA.

Carotid artery imaging and endarterectomy

Carotid artery imaging most frequently took place the day of the clinic (47%, 47/100 respondents). Doppler ultrasound (DUS) was the first line carotid/vertebral imaging in most centres (95%). Most centres (80%) provided the results of carotid artery imaging on the same day, and most centres (86%; 85/99 respondents) provided important positive results immediately. A repeat DUS (19%), or CTA (60%) or contrast MRA (41% of centres) were used as confirmatory tests prior to referral for endarterectomy.

The time between the decision to perform a carotid endarterectomy and the actual surgical procedure was less than one week in 59% of centres and between one and three weeks in approximately 37% of centres (supplementary figure 3). No stroke service performed endarterectomy more than six months after the decision to operate.

Workload volume and capacity

During 2010, on average 4,905 CT brain scans were performed per radiology department (range 20-48,346; median 2,500), 18% were conducted out-of-hours but with considerable variation. On average 686 CT brain scans were for patients with suspected TIA/minor stroke (range 0-5,000 scans; median 200 scans), i.e. about 14% of the total workload. On average, 9% of these CT scans were performed out-of-hours (range 0-60% scans; median 2% scans).

During 2010, on average 2,888 brain MR images were performed per radiology department (range 20-24,391 scans; median 1,530 scans), only 3% of MR scans were conducted out-of-hours (most performed no MR brain imaging out-of-hours). On average, 258 MR brain scans were conducted on patients suspected of TIA/minor stroke (range 0-1,200 scans; median 100 scans), ie about 9% of the total workload.

Forty-three percent of the stroke prevention centres indicated that they had spare capacity to see further patients. Responses varied as to what extra facilities were required to expand the current stroke service (figure 3), 'more consultants' being the most frequent, but 'more carotid imaging' was required in 53%. When 'more brain imaging' was chosen, all respondents opted for more MRI (38/38 respondents) rather than CT (14/38).

DISCUSSION

These simultaneous surveys of stroke prevention clinics and imaging services indicate that the necessary components of stroke prevention services are widely available in the UK, but their structure and organisation vary considerably and an important proportion of practice remains suboptimal (Table 1). In most centres (78%), specialist stroke prevention services operate every weekday with on average five new patients attending each clinic yet only 60% of patients were seen within one week of their event. Additionally, over half the case-load are patients with a final diagnosis of a non TIA/minor stroke 'mimic'. Specialist medical knowledge is required for accurate diagnosis and appropriate medical management of this very heterogeneous case-mix, yet in a quarter of clinics, the main assessment is by nurses.

Table 1. Key findings.

- Nurses provide the primary assessment and diagnosis in nearly a third of clinics;
- 50% of patients attending these clinics have TIA/minor stroke mimic;
- Most patients (75%) have already started secondary prevention treatment before attending the clinic;
- CT for TIA and minor stroke is widely available (94%), is the first line test in the vast majority of centres, and is routinely used in 82%;
- MR is available for TIA and minor stroke patients in 88% of centres but in about half of those it is after an initial CT scan
- There are long delays to MR imaging;
- The key MR sequence needed to diagnose haemorrhage is omitted in more than half of centres, reducing the value of MR;
- Ultrasound is the primary carotid imaging test in 95% of centres;
- There is limited capacity to undertake more imaging although about 40% of stroke services

indicated that they had capacity to see more patients; however the main barrier to seeing more patients was the limited availability of MR.

The consistency between the clinical services' and imaging departments' responses to the question about first line imaging method is striking (figure 2a and figure 2b). Both CT and MR are widely available but access to CT is more rapid and more complete than for MR, particularly outside normal office hours and for outpatients (Supplementary tables 2 and 3). MR was commonly performed in addition to and after CT – possibly somewhat inappropriately since the diagnostic yield from MR for ischaemic lesions on diffusion imaging declines rapidly with time after the event.[15] The survey did not include a question on why MR was performed in addition to CT (or vice versa) therefore we are not able to say why this practice was so common. Furthermore, in more than half the centres, the key MR sequence required to identify haemorrhage accurately (i.e. GRE/T2* or equivalent) was omitted (Supplementary figure 2),[16] increasing the risk that haemorrhages would be misdiagnosed as ischaemic events[17] (one of the two main reasons for brain imaging in TIA/minor stroke) leading to these patients receiving potentially inappropriate antithrombotic or anticoagulant treatment or even offered inappropriate carotid endarterectomy. Some centres that only use DWI and T2 are also likely to miss some stroke/TIA mimics that could otherwise be diagnosed with MR (the other of the two main reasons for brain imaging in TIA/minor stroke). Most patients had already been started on secondary prevention by their GPs before they reached the clinic (supplementary table 1), further questioning the value of MR performed in addition to CT, especially as the MR was frequently too late to be of great diagnostic utility.

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The surveys confirmed that Doppler ultrasound is the main carotid imaging for TIA (95%) not MRA or CTA, perhaps reflecting that the potential for a 'combined brain and carotid' examination (e.g. CT+CTA or MR+MRA) is not practical in most centres. In 59% of stroke services, endarterectomy was performed within one week of the decision to operate. The decreasing delay to surgery is encouraging and in line with guidelines and recent audit reports,[18] but the persistence of delays of up to a month in nearly 40% of patients remains a concern.

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The surveys were targeted to clinical leads of stroke prevention services and radiology departments. Response rate for both surveys was 45% which we considered satisfactory for such a survey in view of the large number of departments surveyed, the busy workload of service leads and their many administrative tasks. The response rates in three previous surveys about stroke services were higher but these took place amongst much smaller catchment groups where many of the respondents knew the surveyors personally and were highly motivated about the topic of the survey.[11-13] The present survey went to a substantially larger number of sites across the whole of the United Kingdom and inevitably could not achieve the same personal touch. The strengths include our use of several mechanisms to prevent sampling bias and increase response rate. We used multiple routes to access all stroke and imaging services clinical leads in the UK and web-based questionnaires for ease of completion. We sent reminders to non-respondents. We reported our findings according to standard methodology (i.e. CHERRIES checklist). We provided web and paper surveys to assist respondents. We based these surveys on several previous surveys of stroke services that achieved high response rates.[11-13]

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There were also limitations. The survey was anonymous and voluntary so we are not able to chart service distribution across the UK. We cannot exclude the possibility that some centres submitted two surveys. To protect the anonymity of the participants we also did not request full demographic details, so were unable to compare respondents with non-respondents. Our findings may, therefore, not apply to all stroke prevention services. Although both internet surveys provided invaluable data to picture current clinical practice, some data were not routinely collected in all centres and respondents were only able to estimate some answers. Not all respondents answered all questions. Even though the 45% response rate for both surveys can be considered satisfactory, we cannot be sure to have captured the full range of performance with respect to current stroke service provision.

There are no other current nation-wide data on clinical services or imaging for stroke prevention in the UK or from other countries. MR usage for stroke is rising rapidly in many countries. For example,

MR use rose by 235% in 10 states in the USA from 1999 to 2008,[19] making diagnostic imaging the single fastest growing component of hospital costs rising by 213% from 1999 to 2008 in the USA.[19] MR was used in addition to CT in about half of the patients, a similar pattern to that found in our survey. The use of several imaging tests will increase delays and further impede rapid access to imaging. The increase in use is occurring despite a lack of evidence in a recent systematic review that MR significantly changed management, or any randomised trials, case-control or cohort studies of imaging strategies to justify its increased use.[20]

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We suggest that use of expensive resources in TIA/minor stroke, such as brain imaging, could be improved by ensuring that patients only have either CT or MR but not both. Where MR is used, then it should be used as fast as possible (beyond a few days after the TIA/minor stroke is unlikely to detect recent ischaemia and would be a waste of time for that purpose) and diagnostic sequences should include those appropriate to avoid misdiagnosing haemorrhage or TIA/minor stroke mimics; this is particularly critical if MR is used in patients whose presentation is delayed beyond seven days when CT will not differentiate haemorrhage. Further consideration should be given to whether widespread use of nurse triage is the most effective way of dealing with complex TIA/minor stroke mimics which generally require some considerable medical experience to differentiate from true TIA/minor stroke.

ARTICLE SUMMARY

Article focus

- Is the current provision of stroke prevention clinical services adequate to meet the volume of work in the UK?
- Is access to brain and carotid imaging adequate to meet the demand and is imaging being used efficiently?
- Who is providing these services?

Key Messages

- Most responding centres had some form of rapid access stroke prevention clinic.
- Front line assessment was by nurses in nearly a third of clinics, but about half of patients have a TIA mimic which requires medical expertise for diagnosis.
- There was efficient use CT brain and carotid ultrasound imaging, but less good access to MR brain imaging and this was often used incorrectly or inefficiently.

Strengths and limitations

- The survey covered the whole of the UK and achieved a 45% response rate.
- Clinical and imaging services responses were highly concurrent.
- Services may be much worse in areas that did not respond.

AUTHOR CONTRIBUTIONS

JM Wardlaw, M Dennis, P Sandercock conceived the idea for the study and secured funding; M Brazzelli, Z Quayum and JM Wardlaw drafted the survey; D Hadley, K Muir, P McNamee, J DeWilde, M Dennis and P Sandercock tested and edited the survey; M Brazzelli and K Shuler set up the final version of the survey into the survey software; M Dennis, JM Wardlaw, M Brazzelli and J De Wilde disseminated the survey as widely as possible; K Shuler and M Brazzelli downloaded the responses, collated and analysed the results; all authors interpreted the results; M Brazelli and JM Wardlaw drafted the paper; all authors contributed critical comments and edited the manuscript; all authors gave their final approval for submission of the manuscript; JM Wardlaw was the principal investigator and takes full responsibility for the integrity and accuracy of the work. Thus all authors fulfil all three ICMJE criteria for authorship: 1) substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; 3) final approval of the version to be published.

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COMPETING INTERESTS

The authors acknowledge funding for the study from the UK National Institutes of Health Research Health Technology Assessment Programme (salary for MB, ZQ). JMW and KM were supported by

the SINAPSE Collaboration. All authors had full unrestricted access to all the study data. The views are those of the authors and not those of the funding agency. There are no other competing interests. JMW takes responsibility for the integrity of the data and the accuracy of the data analysis.

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References

1 Coull AJ, Lovett JK, Rothwell PM, et al. Population based study of early risk of stroke after transient ischaemic attack or minor stroke: implications for public education and organisation of services. *BMJ* 2004;**328**:326.

2 Giles MF, Rothwell PM. Substantial underestimation of the need for outpatient services for TIA and minor stroke. *Age Ageing* 2007;**36**:676-80.

3 Wasserman J, Perry J, Dowlatshahi D, et al. Stratified, urgent care for transient ischemic attack results in low stroke rates. *Stroke* 2010;**41**:2601-5.

4 Rothwell PM, Giles MF, Chandratheva A, et al. Effect of urgent treatment of transient ischaemic attack and minor stroke on early recurrent stroke (EXPRESS study): a prospective population-based sequential comparison. *Lancet* 2007;**370**:1432-42.

5 Lavallee PC, Meseguer E, Abboud H, et al. A transient ischaemic attack clinic with round-the-clock access (SOS-TIA): feasibility and effects. *Lancet Neurol* 2007;**6**:953-60.

6 Bejot Y, Zeller M, Lorgis L, et al. Secondary prevention in patients with vascular disease. A population based study on the underuse of recommended medications. *J Neurol Neurosurg Psychiatry* 2013;**84**:348-53.

7 Sandercock PAG. Should I start all my ischaemic stroke and TIA patients on a statin, an ACE inhibitor, a diuretic, and aspirin today? *J Neurol Neurosurg Psychiatry* 2003;**74**:1461-4.

8 Department of Health Knowledge & Intelligence Branch. Technical Guidance for the 2011/12 Operating Framework. London: Crown 2011:1-261.

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9 Department of Health Payment by Results team. Payment by Results Guidance for 2011-12. London: Crown 2011:1-136.

10 National Institute for Health and Clinical Excellence (NICE). Stroke. The diagnosis and acute management of stroke and transient ischaemic attacks. London: National Institute for Health and Clinical Excellence 2008:1-37.

11 Kane I, Whiteley WN, Sandercock PA, et al. Availability of CT and MR for assessing patients with acute stroke. *Cerebrovasc Dis* 2008;**25**:375-7.

12 Wardlaw JM, Keir SL, Seymour J, et al. What is the best imaging strategy for acute stroke? *Health Technol Assess* 2004;**8**:1-180.

13 Lindley RI, Amayo EO, Marshall J, et al. Hospital services for patients with acute stroke in the United Kingdom: the Stroke Association survey of consultant opinion. *Age Ageing* 1995;**24**:525-32.

14 Eysenbach G. Improving the quality of web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *J Med Internet Res* 2004;**6**:e34.

15 Moreau F, Modi J, Almekhlafi M, et al. Early magnetic resonance imaging in transient ischemic attack and minor stroke: do it or lose it. *Stroke* 2013;**44**:671-4.

16 Dimigen M, Keir S, Dennis M, et al. Long-term visibility of primary intracerebral haemorrhage on MRI. *J Stroke Cerebrovasc Dis* 2004;**13**:104-8.

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17 Wardlaw JM, Keir SL, Dennis MS. The impact of delays in computed tomography of the brain on the accuracy of diagnosis and subsequent management in patients with minor stroke. *J Neurol Neurosurg Psychiatry* 2003;**74**:77-81.

18 Intercollegiate Stroke Working Party. National clinical guideline for stroke. London: Royal College of Physicians 2012:1-208.

19 Burke JF, Kerber KA, Iwashyna TJ, et al. Wide variation and rising utilization of stroke magnetic resonance imaging: data from 11 states. *Ann Neurol* 2012;**71**:179-85.

20 Burke JF, Gelb DJ, Quint DJ, et al. The impact of MRI on stroke management and outcomes: a systematic review. *J Eval Clin Pract* 2012;**doi: 10.1111/jep.12011**.

~~**References**~~

~~1 Coull AJ, Lovett JK, Rothwell PM, et al. Population based study of early risk of stroke after transient ischaemic attack or minor stroke: implications for public education and organisation of services. *BMJ* 2004;**328**:326.~~

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6 Bejot Y, Zeller M, Lorgis L, et al. Secondary prevention in patients with vascular disease. A population based study on the underuse of recommended medications. *J Neurol Neurosurg Psychiatry* 2013;**84**:348-53.

7 Sandercock PAG. Should I start all my ischaemic stroke and TIA patients on a statin, an ACE inhibitor, a diuretic, and aspirin today? *J Neurol Neurosurg Psychiatry* 2003;**74**:1461-4.

8 Department of Health Knowledge & Intelligence Branch. Technical Guidance for the 2011/12 Operating Framework. London: Crown 2011:1-261.

9 Department of Health Payment by Results team. Payment by Results Guidance for 2011-12. London: Crown 2011:1-136.

10 National Institute for Health and Clinical Excellence (NICE). Stroke. The diagnosis and acute management of stroke and transient ischaemic attacks. London: National Institute for Health and Clinical Excellence 2008:1-37.

11 Kane I, Whiteley WN, Sandercock PA, et al. Availability of CT and MR for assessing patients with acute stroke. *Cerebrovasc Dis* 2008;**25**:375-7.

12 Wardlaw JM, Keir SL, Seymour J, et al. What is the best imaging strategy for acute stroke? *Health Technol Assess* 2004;**8**:1-180.

13 Lindley RI, Amayo EO, Marshall J, et al. Hospital services for patients with acute stroke in the United Kingdom: the Stroke Association survey of consultant opinion. *Age Ageing* 1995;**24**:525-32.

14 Eysenbach G. Improving the quality of web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *J Med Internet Res* 2004;**6**:e34.

15 Moreau F, Modi J, Almekhlafi M, et al. Early magnetic resonance imaging in transient ischemic attack and minor stroke: do it or lose it. *Stroke* 2013;**44**:671-4.

16 Dimigen M, Keir S, Dennis M, et al. Long-term visibility of primary intracerebral haemorrhage on MRI. *J Stroke Cerebrovasc Dis* 2004;**13**:104-8.

17 Wardlaw JM, Keir SL, Dennis MS. The impact of delays in computed tomography of the brain on the accuracy of diagnosis and subsequent management in patients with minor stroke. *J Neurol Neurosurg Psychiatry* 2003;**74**:77-81.

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18 Intercollegiate Stroke Working Party. National clinical guideline for stroke. London: Royal College of Physicians 2012:1-208.

19 Burke JF, Kerber KA, Iwashyna TJ, et al. Wide variation and rising utilization of stroke magnetic resonance imaging: data from 11 states. *Ann Neurol* 2012;**71**:179-85.

20 Burke JF, Gelb DJ, Quint DJ, et al. The impact of MRI on stroke management and outcomes: a systematic review. *J Eval Clin Pract* Published Online First: 22 November 2012.doi: 10.1111/jep.12011.

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FIGURE LEGENDS

FIGURE 1. Proportion of patients attending the stroke prevention clinic who were ultimately diagnosed as having TIA or minor stroke. 102/114 centres answered this question.

FIGURE 2. Proportion of patients suspected of TIA/minor stroke who had CT or MRI as first line brain imaging investigation.

A) Imaging services survey (55/146 responders).

B) Stroke prevention services survey (101/114 responders).

FIGURE 3. Resources needed to expand capacity in fully saturated stroke prevention services. 77/114 responded. Participants were asked to choose all suitable answers.

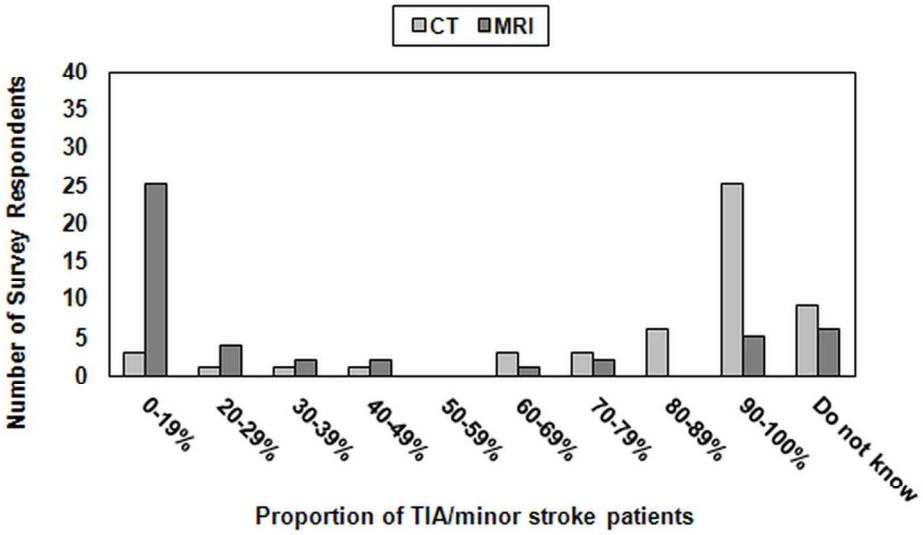

FIGURE 2. Proportion of patients suspected of TIA/minor stroke who had CT or MRI as first line brain imaging investigation.

A) Imaging services survey (55/146 responders).
147x90mm (300 x 300 DPI)

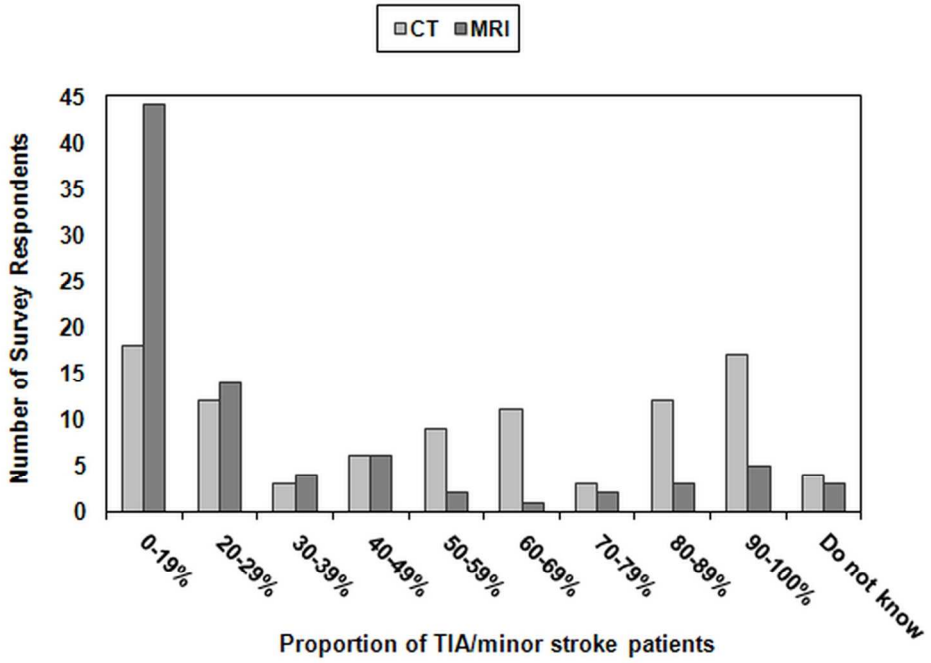

FIGURE 2. Proportion of patients suspected of TIA/minor stroke who had CT or MRI as first line brain imaging investigation.

B) Stroke prevention services survey (101/114 responders).

134x90mm (300 x 300 DPI)

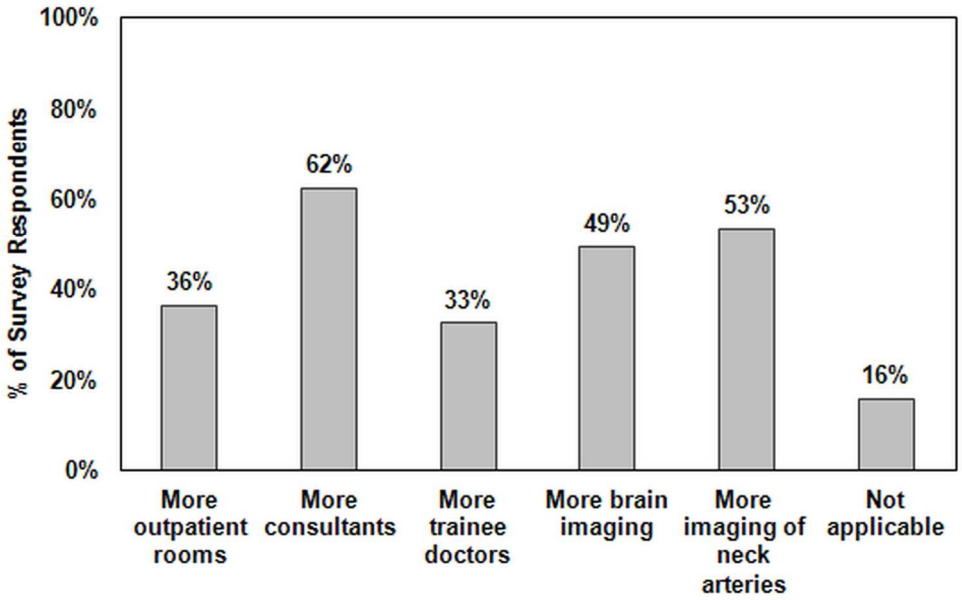

FIGURE 3. Resources needed to expand capacity in fully saturated stroke prevention services. 77/114 responded. Participants were asked to choose all suitable answers.
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SUPPLEMENTARY MATERIAL

Access to CT and MR brain scanning

The imaging services survey indicated that CT was available for TIA and minor stroke in 94% of departments (136/145 respondents) and accessible out-of-hours in 82%. MRI was available in 99% of imaging departments (133/134 respondents) and in 88% was available for TIA/minor stroke, but actual access to MR varied substantially between inpatients and outpatients and by whether the patient presented in or outside weekday office hours.

In most radiology departments that provided this information (49/56, 87%), inpatients and outpatients were managed differently. On weekdays in normal working hours, inpatients were mostly CT scanned and results provided immediately (Supplementary Table 2); of outpatients, only 59% were scanned with CT immediately or the same day and 32% waited 1-2 weeks. Outside normal weekday hours, inpatients could be CT scanned immediately in 67% of centres but was not available in 19%; outpatients commonly had CT scanning delayed by up to two weeks.

Access to MRI was more restricted, 61% (38/62) providing scanning for TIA/minor stroke on weekdays, during normal working hours without difficulty, but the rest with difficulty or not at all (Supplementary Table 3). During normal weekday hours, inpatients had MRI on the same or next day in 72% of centres (39/54 respondents), or within seven days in 26% of centres (14/54). Outpatients had MRI on the same or next day in 32% of centres (15/47 respondents), within 7-14 days in 55% of centres (26/47), and within one month in 11% of centres (5/47). Outside normal weekday hours, MR was not available or could only be performed with difficulty for TIA/minor stroke patients in most centres (48/58, 83% of centres) and could be performed without any difficulty in only 17% of centres (10/58). Out of hours, inpatients had MRI on the same or next day in 64% of centres (27/42), or within seven days in 29% of centres (12/42); outpatients had MRI on the same or next day in 32% of centres (11/35), within 4-14 days in 54% of centres (19/35) and within one month in 14% (5/35) (Table 3). Results for inpatients in normal weekday hours were generally provided immediately (83% of centres), but outpatients could wait up to seven days (27% of centres); reporting times for patients seen out of hours were longer.

Supplementary Table 1 Patients diagnosed as having TIA or minor stroke who had been prescribed secondary prevention drugs prior to attending the Stroke prevention clinic.

% of TIA minor stroke patients already on secondary prevention	% of stroke services (n/N) who answered affirmatively
20% or less	11% (11/100)
21-40%	8% (8/100)
41-60%	20% (20/100)
61-80%	24% (24/100)
81-100%	29% (29/100)

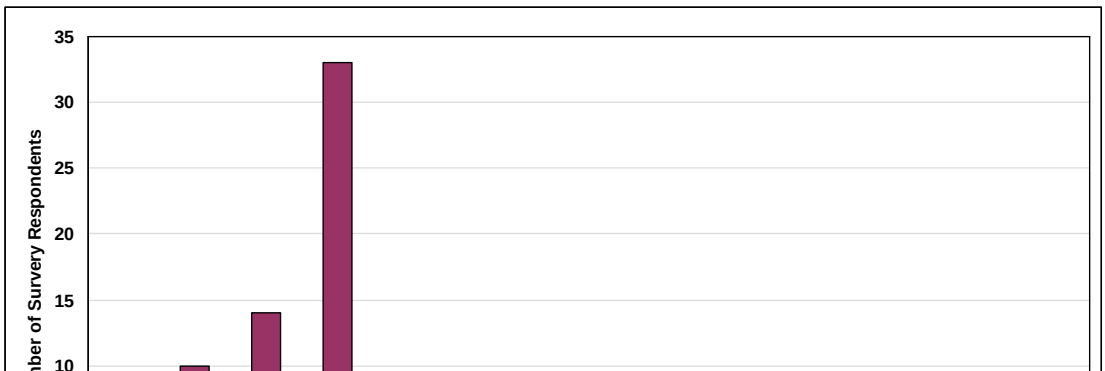
Supplementary Table 2. Operating hours of CT scanning

Weekly CT scanning (Monday to Friday during normal working hours)		
	Inpatients *% (n/N)*	***Outpatients*** *% (n/N)*
Immediately	23% (13/56)	6% (3/51)
Same day	64% (36/56)	53% (27/51)
Next day	11% (6/56)	8% (4/51)
Within 1 week	2% (1/56)	18% (9/51)
Within 2 weeks	0%	14% (7/51)
Within 1 Month	0%	1% (1/51)
Weekend CT scanning (or outside normal working hours)		
	Inpatients *% (n/N)*	***Outpatients*** *% (n/N)*
Immediately	17% (13/52)	12% (5/43)
Same day	48% (27/52)	26% (11/43)
Next day	33% (1752)	28% (12/43)
Within 1 week	2% (1/52)	23% (10/43)
Within 2 weeks	0%	11% (5/43)
Within 1 Month	0%	0%

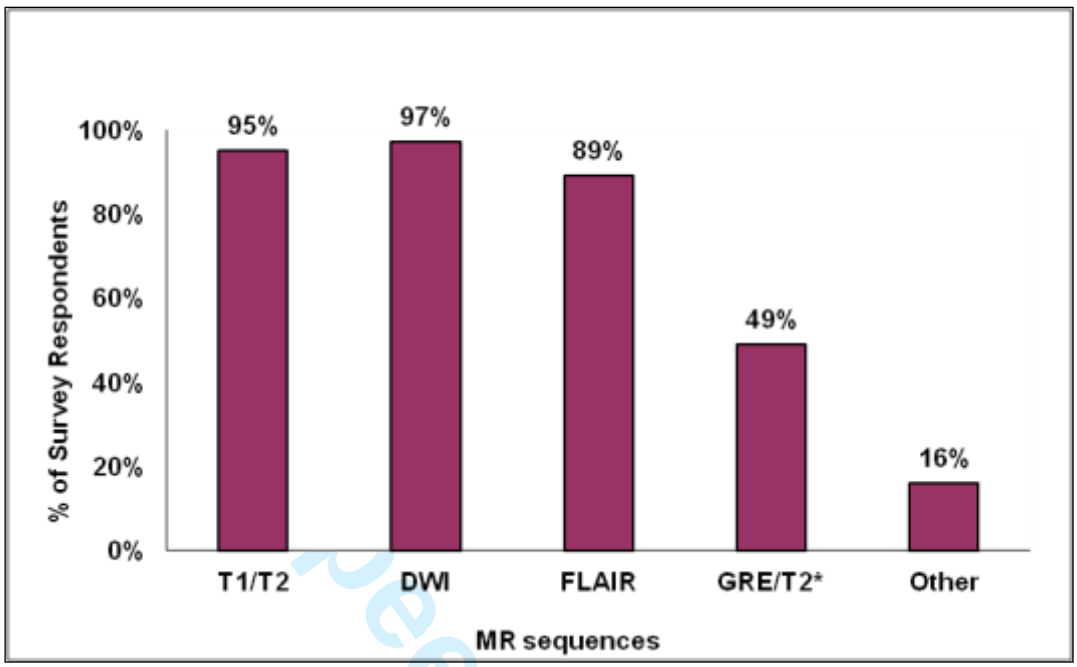
Supplementary Table 3. Operating hours of MR scanning among imaging departments

Weekly MR scanning (Monday to Friday during normal working hours)		
	Inpatients *% (n/N)*	***Outpatients*** *% (n/N)*
Immediately	2% (1/54)	2% (1/47)
Same day	35% (19/54)	21% (10/47)
Next day	37% (2054)	11% (5/47)
Within 1 week	20% (14/54)	30% (14/47)
Within 2 weeks	0%	25% (12/47)
Within 1 Month	0%	11% (5/47)
Weekend MR scanning (or outside normal working hours)		
	Inpatients *% (n/N)*	***Outpatients*** *% (n/N)*
Immediately	5% (2/42)	0%
Same day	14% (6/42)	9% (3/35)
Next day	50% (21/42)	23% (8/35)
Within 1 week	29% (12/42)	40% (14/35)
Within 2 weeks	2% (1/42)	14% (5/35)
Within 1 Month	0%	14% (5/35)

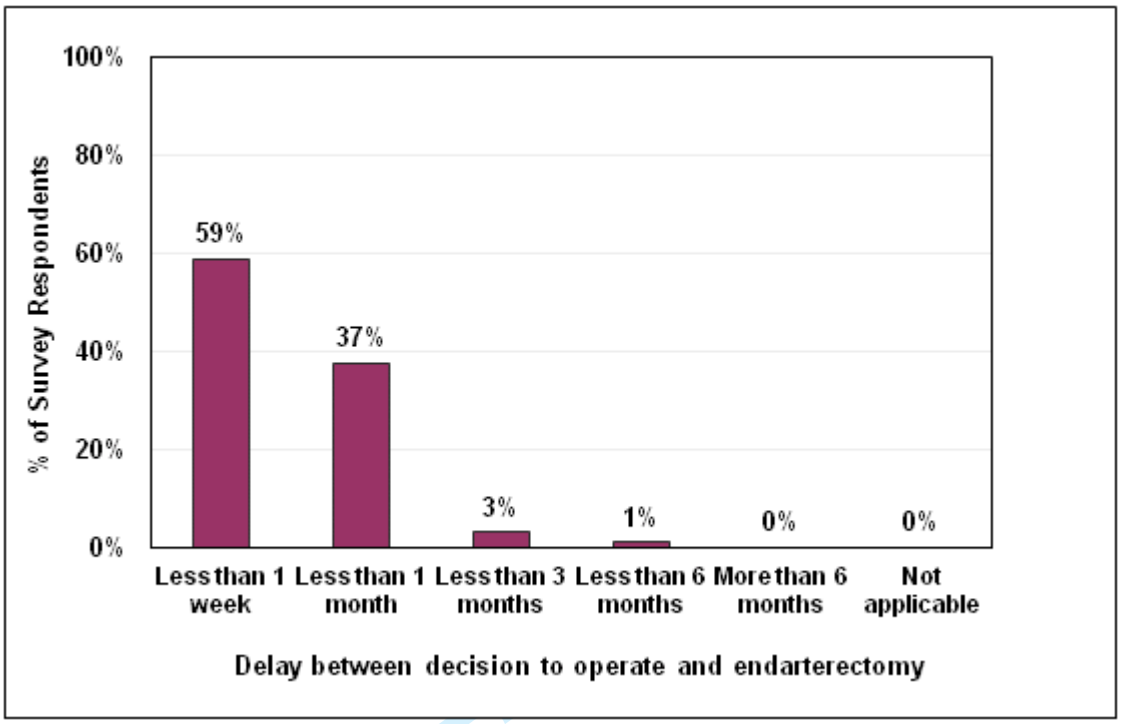
Supplementary Figure 1. Use of MR after CT



Supplementary Figure 2. MR sequences used to assess patients with suspected TIA/minor stroke in the surveyed radiology departments. 128/146 centres answered this question.



Supplementary Figure 3. Delay between the decision to perform endarterectomy and the surgical procedure (99/114 respondents).



Item Category	*Checklist Item*	*YES (the criterion is satisfied)/NO (the criterion is not satisfied)*
Design		
	Describe survey design	YES. The paper provides information on the target population and sample.
IRB (Institutional Review Board) approval and informed consent process		
	IRB approval	Not applicable.
	Informed consent	YES. Participants were informed on the purpose, characteristics and length of the surveys and on the fact that any collected information was treated confidentially. Both surveys included a consent statement to which each participant agreed. The paper refers to the participants' informed consent.
	Data protection	YES. Any information was treated confidentially and anonymity of the participants was preserved. This is stated in the paper.
Development and pre-testing		
	Development and testing	YES. Information on how the surveys were developed and on the initial testing phase is provided in the paper.
Recruitment process and description of the sample having access		

Item Category	*Checklist Item*	*YES (the criterion is satisfied)/NO (the criterion is not satisfied)*
to the questionnaire		
	Open survey versus closed survey	YES. Open surveys. An electronic link was sent to each participant for each questionnaire.
	Contact mode	YES. Methods by which the participants were contacted are clearly described in the paper.
	Advertising the survey	YES. Information on the surveys was disseminated throughout professional bodies' websites and newsletters.
Survey administration		
	Web/E-mail	YES. Information on the type of surveys is reported in the paper. The web links to the two electronic surveys were either e-mail to the participants or posted.
	Context	YES. The paper contains information on how the electronic surveys were developed (survey monkey software) and on the research group who designed them.
	Mandatory/voluntary	YES. Voluntary surveys.
	Incentives	YES. The paper clearly states that no incentives were offered .
	Time/Date	YES. The paper reports the period in which data were collected.
	Randomization of items or	NO. We did not deem necessary to randomize or

Item Category	*Checklist Item*	*YES (the criterion is satisfied)/NO (the criterion is not satisfied)*
	questionnaires	alternate questionnaires.
	Adaptive questioning	YES. According to the answers provided some questions could be skipped.
	Number of Items	YES. Questions were numbered progressively. The number of questions in each questionnaire is reported in the paper.
	Number of screens (pages)	YES. Each page contained a question (in a few cases a sub related question was included in the same page).
	Completeness check	YES. The survey questionnaires had a progress indicator on each page.
	Review step	YES. The participants were able to review and/or change their answers (through a Back button).
Response rates		
	Unique site visitor	NO. We did not formally put in place a mechanism to determine the number of 'unique visitors'. However we asked the participants to provide their demographic information and we used these details to check the relevant centres/hospitals in the UK that replied to the questionnaires.
	View rate (Ratio of unique survey visitors/unique site visitors)	NO.
	Participation rate (Ratio of unique visitors who agreed to participate/unique first survey	NO. We were not in the position to determine a 'recruitment rate'. As for the way the surveys were developed and disseminated, we were not able to

Item Category	*Checklist Item*	*YES (the criterion is satisfied)/NO (the criterion is not satisfied)*
	page visitors)	count the number of people who agreed to participate and divide it by the visitors who visit the first page of the survey.
	Completion rate (Ratio of users who finished the survey/users who agreed to participate)	YES. Information on completion of both questionnaires is described in the paper.
Preventing multiple entries from the same individual		
	Cookies used	Not applicable . Survey Monkey software does not allow for cookies to be used.
	IP check	Not applicable. We were not in the position to prevent users with the same IP address to access the surveys twice.
	Log file analysis	NO. No specific techniques to analyse the log file for identification of multiple entries were used.
	Registration	NO. No specific techniques were used to prevent duplicate entries from the same user. However, demographic information was provided by the participants and we used these details to check for duplicate entries.
Analysis		
	Handling of incomplete questionnaires	YES. Completed and partially completed questionnaires were analysed.

Item Category	*Checklist Item*	*YES (the criterion is satisfied)/NO (the criterion is not satisfied)*
	Questionnaires submitted with an atypical timestamp	Not applicable. We were not in the position to measure the time people needed to fill in the questionnaires and exclude those that were completed too soon or within a pre-determined timeframe.
	Statistical correction	NO. No specific methods were used to adjust for the non-representative sample.