Paper

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CLINICAL

A pilot survey of decisions by acute medicine staff after thunderclap headache

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ABSTRACT

Introduction and aims: Traditionally, neurologically pristine patients with a thunderclap headache are investigated with a non-contrast computed tomography (CT) brain scan, which if negative is followed by a lumbar puncture (LP) to exclude important secondary causes, particularly subarachnoid haemorrhage (SAH). However, misdiagnosis of such patients is still a cause of significant human and financial cost and a regular reason for medical litigation. This study explores the approach of emergency medicine and acute medicine clinicians to the investigation of a patient with thunderclap headache.

Methods: Clinicians were invited to complete an online survey based on a clinical vignette of a 45-year-old man presenting with a thunderclap headache who had a pristine neurological examination.

Results: A total of 160 clinicians responded. The majority (89%) elected to perform a non-contrast CT brain as their first investigation, though five clinicians discharged the patient without investigation. If the CT was negative, only 84% would then proceed to LP, but 20% would undertake this investigation before 12 hours from headache onset.

Conclusions: Most clinicians investigate neurologically intact patients with thunderclap headache following a CT/LP strategy, but deviations from recommended practice are common.

KEYWORDS Headache, intracranial aneurysm, subarachnoid haemorrhage, survey, thunderclap headache

DECLARATION OF INTERESTS No conflicts of interest declared.

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Headache accounts for 1–4% of Emergency Department (ED) attendances[1–4] and is a common reason for admission to acute medical receiving units. Non-traumatic subarachnoid haemorrhage (SAH) can present in a number of different ways, from collapse with a reduced level of consciousness to acute confusion[5] or seizures[6] but in those able to speak, the primary complaint is usually of sudden and severe (thunderclap) headache.[7]

Subarachnoid haemorrhage represents 1–3% of all cases of ED headache[4,8] and perhaps 12–14% if 'worst ever headache' only is considered.[9,10] Approximately 5% of all strokes are due to SAH which has an annual incidence of 6–10/100,000.[11–14] Mortality from SAH remains high at 45–50%[14–16] and many survivors suffer significant physical and cognitive disability.[16,17] Compared with other types of stroke, SAH affects a younger age group[18] and results in significant human and financial cost.[12,14,19]

The term thunderclap headache describes a severe headache of rapid onset, typically reaching maximum intensity in less than one minute.[20] The thrust of most diagnostic strategies is the exclusion of life-threatening vascular causes, particularly SAH, though also cervical artery dissection, cerebellar haemorrhage and cerebral venous sinus thrombosis.

The likelihood of SAH correlates well with reduced conscious level or the presence of abnormal neurology[14,21] and in such patients the decision to investigate is usually straightforward. However, the incidence of SAH in patients with acute severe headache presenting to the ED with a normal neurological examination may be as high as 10%[9,22] and it is this population that poses the greatest diagnostic challenge.

Misdiagnosis with consequent death or severe disability is more likely in this group.[23] A careful history is key to initiating investigation for SAH in an alert patient with normal neurology. Important correlates are worst ever headache,[9] particularly of rapid onset,[22] usually in seconds (though sometimes minutes), and perhaps with associated seizure.[21] The key diagnostic feature of the history is, therefore, sudden onset of a severe, 'worst ever' headache.[24] A headache failing to reach maximal intensity within a few minutes is unlikely to be due to SAH.[20] Site and character of the headache are not helpful in making the diagnosis and occasionally the headache may be mild[25] or relieved with simple analgesia.[26] There are no other historical features or associated symptoms in neurologically normal patients that have been shown to be independently helpful in making the diagnosis.

A failure of medical staff to recognise critical clues from the basic history, notwithstanding subsequent non-invasive imaging results, will miss the very group who have most to gain from timely diagnosis and treatment.[23]

Association with increased physical exertion has been demonstrated[27] but most episodes of SAH occur at periods of relative inactivity.[28] Also, the value of the 'sentinel headache' or 'herald leak' is questioned. In cases of suspected SAH, based on relevant suggestive features in the presentation, national guidelines and expert opinions recommend a non-contrast computed tomography (CT) of the brain as the initial supportive investigation, possibly followed by subsequent investigations to explore the diagnosis further, even when this is normal.[24,29,31–33]

Three reasons for misdiagnosis are repeatedly highlighted:[14,30]

1. Failure to consider the diagnosis of SAH.
2. Failure to obtain and correctly interpret the results of a CT brain scan.
3. Failure to perform and interpret correctly the results of a lumbar puncture (LP).

The diagnosis of SAH should be considered in all patients presenting with first or worst headache, particularly of sudden onset. In neurologically normal ED patients CT probably has an overall sensitivity of 92–93% for the detection of SAH, though this may be higher, some even suggest 100%, if contemporary CT imaging standards of scanning are used, within six hours of onset of headache.[34,35] Sensitivity drops to 85% at three days, 50% at one week[18] and to an estimated 30% by two weeks.[36]

Since a negative CT scan is not sensitive enough to exclude SAH, it should be followed by an LP, performed at least 12 hours after the index headache.[24,29,31–33] Cerebrospinal fluid (CSF) samples should be shielded from the light, studied for xanthochromia (yellow hue) and have spectrophotometric analysis for bilirubin within an hour.[10,37]

If both CT and LP are negative, SAH can effectively be excluded, a strategy which holds true up to two weeks from the headache onset.[38] Routine performance of a CT/LP strategy in neurologically normal patients has been questioned, both on Bayesian probabilities CT analysis[39] and because CT scanners are more sensitive, at least in the first six hours.[35,40,41]

In Scotland, patients attending hospital with acute headache will usually initially be managed by Emergency Medicine (EM) or Acute Medicine (AM) clinicians. This survey presented to clinicians (who manage these patients on a regular basis) a patient with a good history of a thunderclap headache (possibly due to SAH) who also had normal neurological examination. The aims were to identify the proportion of clinicians who considered SAH (a life-threatening condition) to be excluded and to evaluate approaches to investigation in light of established guidance.

METHODS

The survey was constructed around the following single short clinical vignette based on local data of typical presentations to the EM and AM services in our institution:

'A 45-year-old man presents after a severe (10/10), rapid onset (<1 minute), occipital headache. There was no collapse and he has no other symptoms. At the time you assess him his headache has subsided to 2/10 with ibuprofen and paracetamol given in triage. It is now five hours since the onset of his headache. He has no history of headaches and no other relevant medical or family history. He has no neurological signs, is alert and orientated and has normal vital observations.'

Respondents were asked which initial investigation (if any) they would perform. Subsequent information was then revealed, according to their answer, stating that their chosen initial investigation was normal and that the patient's condition remained unchanged. Respondents were then asked what investigations (if any) they would further perform and how they would manage the patient at each stage if the requested investigations were normal. At each step clinicians were also given the option of referring to a specialist if this would be their normal practice.

Information was also gathered regarding the existence of a local protocol for the management of patients with thunderclap headache, collection and analysis of CSF, patient disposition and follow-up.

The survey was registered with the NHS Grampian Clinical Effectiveness Unit and agreement for the study obtained from the North of Scotland Research Ethics Service.

Each hospital in Scotland with an ED or Acute Medical Unit was contacted by phone to identify a senior clinician in both EM and AM who was willing to provide a local departmental email distribution list. Email addresses of all the Scottish Members and Fellows of the College of Emergency Medicine and the Society of Acute Medicine were also obtained. Every effort was made to exclude duplicates prior to sending the questionnaire ,but one address list was used blindly, resulting in an unknown number of duplicate invitations.

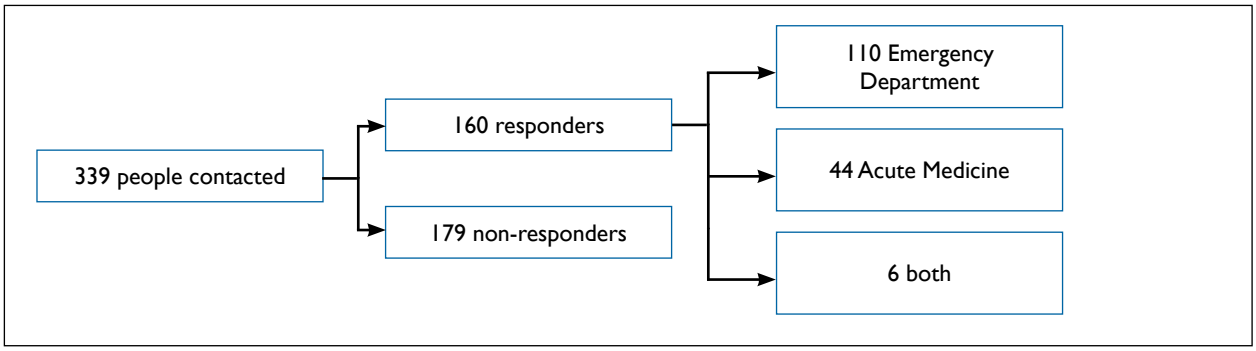

FIGURE 1 Specialty of responders.

A request to complete the online survey was emailed to Consultants, Staff Specialists and Senior Trainees (ST3+) in EM and AM working in Scotland. The first mailing took place in June 2010, with three subsequent reminders at fortnightly intervals.

RESULTS

A total of 339 clinicians were emailed and 160 responses were gathered. There may have been up to 103 duplicates, giving a response rate of 47–67%. In 19 cases documentation was not complete. The questionnaire allowed for not all respondents answering every question so that some subsidiary questions were omitted if there were certain responses to a stem question; therefore the denominators in our results vary.

Of those who responded, 110 (69%) worked in EM, 44 (28%) worked in AM and six (4%) covered both specialties (Figure 1). The majority (86%) were consultants or specialty doctors and 14% were trainees – ranging from ST3 to ST6 (Figure 2).

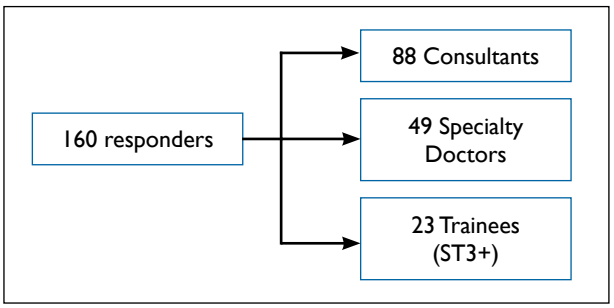

FIGURE 2 Grade of responders.

First investigation

As illustrated in Figure 3, 139 doctors would initially investigate the described patient with a non-contrast brain CT. Two clinicians would go direct to non-invasive angiography and a further five (3%) would have discharged the patient without any investigation at all.

Second investigation

Of those 141 clinicians who initially elected to image the patient, 119 (84%) would proceed to LP if the result was normal. One clinician elected to perform non-invasive angiography as second-line and eight (6%) would discharge the patient without performing a second investigation.

Third investigation

Of the 119 clinicians who performed an LP as their second investigation, 112 (94%) would be content that no further investigation was required, though only 44 (37%) of this group would be content to discharge this patient directly without referral. Seven clinicians would continue to investigate this patient with a magnetic resonance image (MRI) (n=2) or non-invasive angiography (n=5). The single clinician who performed non-invasive angiography as a second investigation would proceed to LP if this were normal.

Fourth investigation

No respondent elected to perform a fourth investigation or requested investigations that were not listed. Of the clinicians who performed a third investigation (n=8), four would be content to discharge the patient if this were normal. The remainder would refer on.

Local protocol

Only 35 (22%) respondents were aware of a local protocol for investigation of acute headache.

Collecting and analysing CSF

Of those who said they would perform an LP in this clinical situation, only 115 of 143 (80%) would wait until 12 hours had elapsed from the index headache. Ninety-four (69%) would perform the LP in the lateral position and 107 (79%) would measure opening CSF pressure. Some respondents (n=61, 44%) expressed no preference regarding the gauge of spinal needle used, but of those who did, a 22 gauge (G) needle was the most common choice (Table 1). A cutting needle (rather than pencil point) was preferred by 39% (n=37). The recommendation of recumbent bed rest post LP

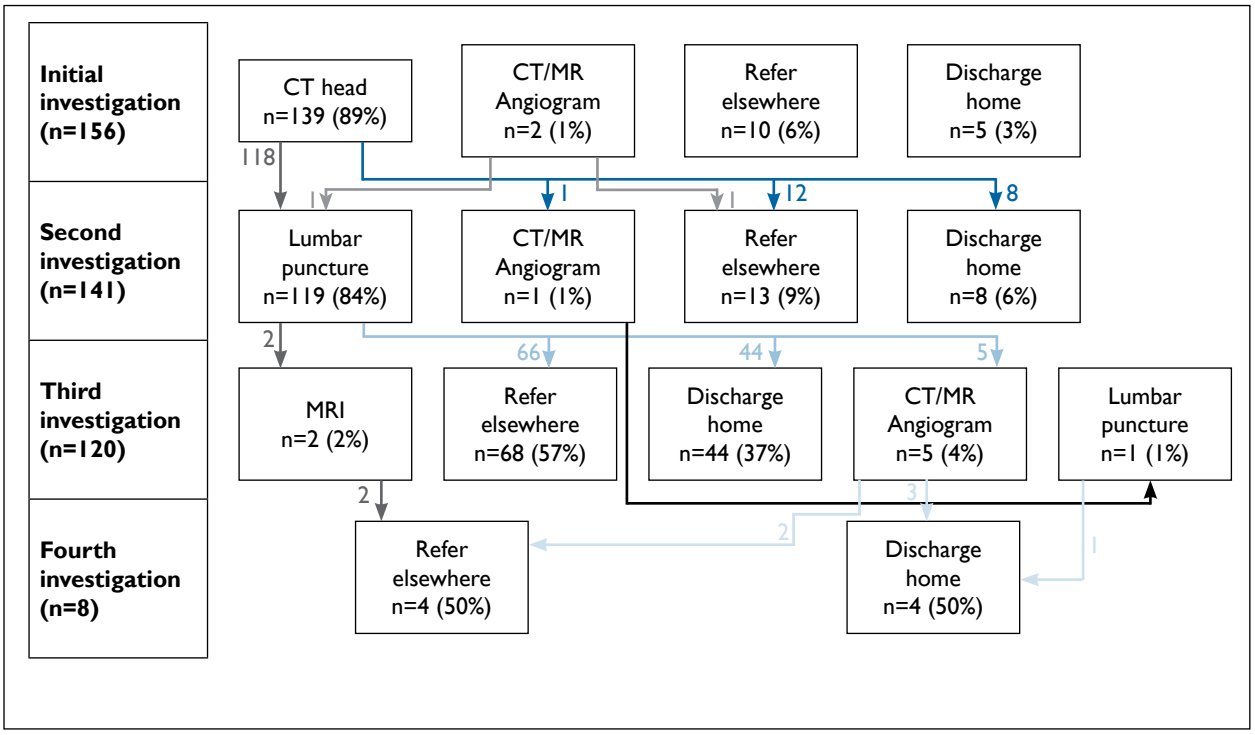

FIGURE 3 Order of investigations/referrals.

TABLE 1 Gauge of lumbar puncture needle preferred

Needle gauge (G)	n	%
20G	10	7
22G	30	22
23G	4	3
24G	16	12
25G	11	8
26G	5	4
27G	2	1
Unsure	61	44

TABLE 2 Post-procedural advice

Lying flat post-procedure	n	%
No	22	16
For at least one hour	43	32
For 1–2 hours	28	21
For 2–4 hours	22	16
For 4–6 hours	13	10
For over 6 hours	7	5

procedure was also variable (Table 2). Procedures around CSF sample handling and analysis were distinctly non-uniform (Table 3).

Not all respondents had facilities for spectrophotometric testing. During office hours 86% had access, falling to 57% at the weekend and 25% overnight. Twenty-nine of 142 clinicians (20%) would discharge patients without a spectrophotometry result if the CSF was clear to the naked eye and acellular on microscopy. Similarly, some clinicians (n=8) discharged the patient after a negative CT.

DISCUSSION

Our pilot, contemporary study adds to the extensive literature stating that the inappropriate practices of some doctors would miss the diagnosis of a sub-group of SAH for which timely treatment could achieve great benefits in terms of preventing future acute, life-threatening intracranial emergencies. Considering, investigating and confirming this diagnosis is essential – for the patient, the doctor and the emergency team and the NHS.[14] The best outcomes for all (over 90% cure and reduced recurrence risk) are most probable if the diagnosis is made when the patient is alert, oriented and without focal signs. The recommended pathway of CT and, if negative, LP is well-founded and, in Scotland at least, remains the most usual method of investigating patients with thunderclap headache. However, there are clearly marked variations in practice between clinicians (and institutions) regarding investigation.

Overall, only 28% of respondents followed the CT-LP-discharge route. An additional 43% started this pathway but later referred the patient and a further 15% said they would perform the CT and LP but then refer the patient elsewhere rather than discharging them.

TABLE 3 Handling and processing of cerebrospinal fluid samples

Cerebrospinal fluid (CSF) samples	Always		Sometimes		Never	
	n	%	n	%	n	%
Transported protected from light	42	36	25	21	51	43
Arrive at lab within one hour	96	78	24	20	3	2
Sample sent for microscopy/culture	120	93	9	7	0	0
Sample sent for virology	42	34	79	63	4	3
Visual inspection for xanthochromia	98	78	12	10	16	13
Spectrophotometry for xanthochromia	110	92	8	7	2	2
Results available within two hours	46	40	53	46	16	14

Clinical assessment

A small number of physicians (n=5) were content not to investigate at all, perhaps basing their judgement on the normal neurological examination and improvement of symptoms with analgesia. Not to perform investigation of these patients has been cited as one of the three main reasons for misdiagnosis.[36] In Canada, there have been attempts to define a robust clinical prediction rule to exclude the diagnosis of SAH without imaging. Initial results are promising, but recommendations cannot be made until these are validated prospectively and in other populations.[42] Should this research have been applied to the patient in our vignette, a CT of the head would still have been indicated on account of age.

The clinicians (n=8) who discharged the patient after a negative CT brain were neglecting the variability of the negative predictive value of an unenhanced CT for the detection of SAH. The largest study in this field (published since the time of our survey) analysed 3,132 neurologically intact patients with 'worst ever' headache, and using a modern, multi-row detector third-generation CT scanner achieved an overall sensitivity of 92.9% (95% confidence interval [CI] 89.0–95.5%) in SAH detection.[35] However, analysis of those 953 patients scanned within six hours showed that all 121 cases of SAH were detected (sensitivity 100%; 95% CI 97–100%).[35] This is consistent with a previous report that found no instance of missed SAH in 305 neurologically intact patients scanned within six hours of headache onset (sensitivity 100%; 95% CI 92–100%).[34] The vignette in our survey suggests that the patient is being assessed within five hours of headache onset, so some may consider a negative CT brain scan in a neurologically normal patient is sufficient to rule out SAH. Since institutions vary regarding access to CT scanning and the equipment available, as well as the expertise and timeliness of reporting, many will not adopt a 'CT rule-out' strategy until further large studies have been evaluated.

This survey revealed that a number of clinicians would use CT/MR angiography as a first-line investigation or as a follow-up investigation should non-contrast CT or LP show no evidence of SAH. Without CT or LP evidence of SAH an angiographic finding of an intracranial aneurysm (present in around 2% of the population)[43] may be incidental. The natural history of asymptomatic aneurysms is not easy to predict and while large (>10 mm) aneurysms have a rupture rate of around 1% per year[43] the majority are small and have a rupture rate of only 0.05% per year.[44] Discovering a small asymptomatic intracranial aneurysm may therefore result in difficult clinical decisions, patient anxiety and the potential harm from over investigation or treatment.

Lumbar puncture performance

This study demonstrates that about one in five clinicians would perform an LP sooner than 12 hours after the index headache and would thus ignore a national recommendation in the UK.[37] The evidence for waiting 12 hours is based on the simple pathophysiology of bilirubin formation in the CSF of patients who have suffered a small SAH,[45] and on a study demonstrating the consistent presence of CSF xanthochromia in 111 patients with CT-proven SAH.[46] Clinicians expressed a preference for using large diameter Quincke (or cutting) spinal needles (20G or 22G) for CSF collection. These larger needles cause increased incidence of post-dural puncture headache (PDPH) compared with those of narrower gauge,[47] particularly with atraumatic tips (e.g. Sprotte or Whitacre), but do allow quicker measurement of opening pressure and sample collection.[48] Despite no evidence that the duration of recumbency after the LP prevents PDPH,[47] many clinicians still advise strict bed rest after an LP; only 22% suggested early mobilisation.

CSF handling

There was significant deviation from the National External Quality Assessment Service (NEQAS) recommendations for CSF handling.[37] Failure to protect samples from the light and prolonged storage increases bilirubin decay and may lead to false negative results.

Spectrophotometry is the recommended method of CSF analysis in the UK,[37] detecting bilirubin (from

haemoglobin breakdown) in the CSF. Bilirubin levels peak at 48 hours post-SAH, and it may be detected for up to four weeks.[49] Visual inspection only for xanthochromia is the norm in the United States, a technique that is specific but poorly sensitive compared with spectrophotometry.[50] Conversely, spectrophotometry may have as little as 29% specificity for the detection of SAH, resulting in false positives that require subsequent investigation with angiography.[51] However, it is possible that some cases of a positive LP that go on to have a normal angiography may represent small non-aneurysmal (perimesencephalic) bleeds not picked up on CT.

Further, a proportion of respondents would discharge patients home without a spectrophotometry result if CSF was clear to the naked eye and there were no red cells on microscopy. The safety of this practice is not known, though a review of 68 angiogram-confirmed SAH showed that 3% had no red blood cells on LP despite being xanthochromia positive.[52]

STRENGTHS AND WEAKNESSES

Our survey was based on a short and uncomplicated scenario of a neurologically normal patient with a thunderclap headache. This is one of the few areas of medicine where, for many years, there has been a consistently structured investigation pathway. As the quality of key investigations such as CT improves, the opportunity for effective management, including the prevention of disease complications, grows. There is, however, an ongoing need to re-evaluate the characteristics and performance of diagnostic tests in the population concerned.

The study questions were hypothetical and do not allow for the effect of patient preference or variations in access to investigations and results within different institutions. Real-life practice will always differ from a clinical 'ideal' due to uncontrollable circumstances (for example the patient's wishes or contraindications to a specific investigation).

In this study the response rate was low (47–67%), but this weakness is common in similar questionnaire research. Nevertheless, the survey represents a recent study specifically demonstrating the varying approach to aspects of the investigation and diagnosis of thunderclap headache in the UK in the period between 2010 and 2011.

CONCLUSIONS

Investigation of patients presenting with a thunderclap headache is commonly undertaken by non-specialists, but knowledge of the correct methods to detect or exclude SAH is imperative if patients are to avoid harm from misdiagnosis. While most EM and AM clinicians follow a standard CT/LP strategy, this is not universal. Future work should focus on factors influencing decision-making in this clinical area. Standardisation of the management of these patients, knowledge of the predictive values of investigations ordered, and the development of locally agreed protocols may ensure more consistent and evidence-based management of patients with this common presentation.

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