Clinical Presentation and Assessment of Older Patients Presenting with Headache to Emergency Departments: A Multicentre, Observational Study

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Clinical Presentation and Assessment of Older Patients Presenting with Headache to Emergency Departments: A Multicentre, Observational Study

ABSTRACT

Objective: To describe the characteristics, assessment and management of older Emergency Department (ED) patients with non-traumatic headache.

Methods: Planned sub-study of a prospective, multicentre, international, observational study which included adult patients presenting to ED with non-traumatic headache. Patients aged ≥75 years were compared to those aged <75 years. Outcomes of interest were epidemiology, investigations, serious headache diagnosis and outcome.

Results: 298 patients (7%) in the parent study were aged ≥75 years. Older patients were less likely to report severe headache pain or subjective fever (both p<0.001). On examination older patients were more likely to be confused, have lower Glasgow Coma Score and new neurological deficits (all p<0.001). Serious secondary headache disorder (composite of headache due to subarachnoid haemorrhage (SAH), intracranial haemorrhage, meningitis, encephalitis, cerebral abscess, neoplasm, hydrocephalus, vascular dissection, stroke, hypertensive crisis, temporal arteritis, idiopathic intracranial hypertension or ventriculoperitoneal shunt complications) was diagnosed in 18% of older patients compared to 6% of younger patients (p<0.001). Computed tomography brain imaging was performed in 66% of patients ≥75 years compared to 35% of younger patients (p<0.001). Older patients were less likely to be discharged (43% vs 63%, p<0.001).

Conclusion: Older patients with headache had different clinical features to the younger cohort and were more likely to have a serious secondary cause of headache than younger

adults. There should be a low threshold for investigation in older patients attending ED with non-traumatic headache.

Keywords: headache, emergency department, epidemiology, aged

PRACTICE IMPACT STATEMENT

In this international multicentre study, a serious headache disorder was diagnosed in 18% of patients aged ≥75 years compared to 6% of younger patients. Older patients had higher imaging utilisation rates, receiving a computed tomography scan of the brain in 66% of presentations compared to 35% of younger patients. In contrast to younger patients, patients aged ≥75 years were more likely to report mild pain, and less frequently reported associated fevers, nausea, vomiting and photophobia. There should be a low threshold for investigation in older patients attending ED with non-traumatic headache.

INTRODUCTION

Headache makes up a significant proportion of emergency department (ED) visits.[1-3] In a recent population-based United States (US) study, headache was the fifth most common reason to present to EDs, representing 3% of all visits.[1] Little is known about the epidemiology of older patients who present to the ED with headache. Prior neurology-based studies have shown the incidence of patients presenting with headache decreases with age, but the risk of headache due to serious conditions increases.[4-6] The prevalence of migraine is known to decrease with age[4-7] and likely contributes to this decline in total headache presentations. Concern that a headache may represent a secondary headache disorder caused by a serious condition such as stroke, temporal arteritis, or intracranial malignancy increases in older populations. In a previous single-centre study of patients aged >65 referred to a neurology service with new onset headache, 15% had a secondary headache disorder with a serious underlying cause.[6]

Increasing age is cited as a 'red flag' for identification of serious secondary headache disorders in the ED.[8-12] Emergency medicine research supports age over 40 as a risk factor for subarachnoid haemorrhage.[9] Age over 50 has been identified as a risk factor for identification of serious secondary causes of headache.[10-13] Reflecting this evidence, clinical guidelines recommend that clinicians consider diagnostic work-up of headaches for severe underlying cause in patients with increasing age.[8,14-15] Little is known regarding the ways that older people's headache signs and symptoms may differ from younger patients. Anticoagulation use, polypharmacy and increased comorbidities further complicate the diagnostic work-up and management of older patients. There is a shortage of real-world

data specific to ED patients describing the differences in clinical characteristics, management and outcomes of older patients with headache.

Generally, the objective of the Headache in Emergency Departments (HEAD) study was to describe the epidemiology of non-traumatic headache in adults presenting to the ED including clinical presentation, investigations and disposition.[16] In this planned sub-study, we focus on patients aged 75 years or older and their comparison with patients <75 years with headache. This group is underrepresented in research and is likely to have specific characteristics which may impact their care. We hypothesised that this study would confirm previous research that serious secondary causes of headache are more common in older people.

METHODS

Design and settings: This was a planned sub-study of a prospective multicentre observational study conducted over one calendar month in 2019 (for most sites March 2019), the Headache in Emergency Departments (HEAD) Study.[16]

Participants and recruitment: For the parent study, participants were adult patients (aged ≥18 years) with non-traumatic headache as their presenting complaint. Exclusion criteria were history of trauma to the head within 48 hours of presentation, missing records, inter-hospital transfers, re-presentation with the same headache as a recent previous visit and headache as an associated symptom rather than a main complaint. Determination of whether headache was a primary complaint was at the discretion of the local researcher based on all available data.

Qualifying adult patients presenting during the study period were identified from ED data management systems. Patients were identified prospectively but, depending on site resources, some data were collected retrospectively.

Data collected and data collection process: Data collected included demographics, clinical assessment, investigation, treatment, diagnosis, disposition and outcome. Data were collected from clinical records by local researchers onto piloted data forms or directly into the study database (depending on local processes and resources). Study data were collected and managed using REDCap electronic data capture tools hosted at the Joseph Epstein Centre for Emergency Medicine Research [Melbourne, Australia]. For the majority of sites, the data were collected in March 2019, with some minor variations following delays in ethical/governance approval.

Outcomes of interest: The primary outcomes of interest of this sub-study were the differences in epidemiology, investigations, serious secondary headache diagnosis and

disposition of patients aged 75 years or older presenting to the ED with headache. We chose 75 years as the cut-off consistent with recent recommendations.[17-18]

Severe headache was defined as pain score 7-10. Thunderclap headache was defined as headache peaking instantly or almost instantly. This was distinguished from headache that reached peak intensity within one hour but not instantly.

We defined non-migraine benign headache as the composite of those classified as primary, tension, cluster or musculoskeletal following clinical assessment and initial management. Migraine is reported separately. As in the parent study, serious secondary headache disorders were defined as the composite of headache due to subarachnoid haemorrhage (SAH), intracranial haemorrhage, meningitis, encephalitis, cerebral abscess, neoplasm, hydrocephalus, vascular dissection, stroke, hypertensive crisis or pregnancy-related hypertension, temporal arteritis, idiopathic intracranial hypertension or ventriculoperitoneal shunt complications, noting that pregnancy-related hypertension would not apply to patients aged >75 years.

Analysis and sample size: As this was a descriptive study, a formal sample size calculation was not performed. Descriptive analysis was performed using indicators of central tendency in normal distributed variables and frequencies in discrete variables. Non-parametric analyses were used as required. Comparison of proportions was analysed by chi square or Fisher's test as appropriate. The study is reported in accordance with STROBE guidelines for observational work.[19] Because this study was a sub-study, no a priori sample size was calculated. Post hoc power calculation was undertaken using University of British Columbia on-line power/sample size tool.[20] For the endpoint of serious secondary headache, to identify a difference in rate of 7% (i.e., a doubling from 7% in the parent study[16] to 14%) with α of 0.05 and power of 0.8 required 129 patients.

Ethical approvals: The lead ethics approval was by Melbourne Health Human Research Ethics Committee (HREC/43148/MH-2018). Ethics approval was subsequently obtained for each participating site according to local institutional requirements. In most jurisdictions the study was conducted under waiver of consent. Patient consent was required in a few jurisdictions. In some Queensland sites, formal consent was required. This was verbal. In the United Kingdom (UK), an opt-out approach was used, and approval obtained through the Health Research Authorisation following application and review by committee (REC reference: 19/SW/0089).

The study was prospectively registered with the Australia and New Zealand Clinical Trials Register (trial number 376695).

RESULTS

A total of 4,536 patients presenting with headache were included in the parent study across 67 hospital groups (74 EDs) in 10 countries (Australia 34, New Zealand 10, Turkey 9, UK 7, Singapore 4, Belgium, 4, France 3, Romania 1, Hong Kong 1, Israel 1). For hospitals that provided caseload data, headache patients accounted for 1% of ED caseload (95% CI 0—1%). Two hundred and ninety-eight (7%) of the 4,536 patients were aged 75 years and over. The distribution by country is summarised in Appendix 1.

Patient demographics are summarised in Table 1. There was no difference in the proportion referred by a doctor or the duration of symptoms prior to presentation by age cohort. The older patient group was approximately three times more likely to arrive by ambulance. There were significant differences in triage category allocation with immediate or urgent triage categories more frequently assigned to patients in the older age group. Older patients were also more likely to have a past history of stroke/transient ischaemic attack (TIA), active noncerebral malignancy, intracranial aneurysm without haemorrhage and long-acting anticoagulant use. A past history of physician-diagnosed migraine was less common in the older age group (6% vs 22%).

Clinical symptoms are summarised in Table 2. Onset of symptoms and headache location proportions were similar between the age groups as were moderate pain scores and the percentage of participants who described their headache as their worst ever. Severe pain was less common and mild pain was more common in the older group compared to younger patients. Nausea or vomiting, reported photophobia, and subjective fever or rigors were all also less common in older patients. Patient-reported new limb weakness or new speech difficulty were more common in the older age group. Syncope and reported neck pain or stiffness were distributed equally.

Examination findings are summarised in Table 3. New neurological signs (8% vs 3%), lower Glasgow Coma Score (GCS) and confusion (5% vs 1%) were more common in older patients. Demonstrable meningism was distributed equally.

Diagnostic imaging investigations, dispositions and outcomes are summarised in Table 4. Computed tomography (CT) of the brain was performed almost twice as often in the older age group (66% vs 35%). Lumbar puncture was performed much less frequently in older patients, There was no difference between the age groups with respect to magnetic resonance imaging (MRI), CT angiography, CT plus MRI or CT plus CT angiography, all of which were uncommonly performed (all less than 5% of total patients). More patients in the older age group required hospital admission.

The final ED diagnosis is shown in Table 5. With respect to specific diagnoses, migraine was less common in the older patient group compared to younger patients. Stroke/transient ischaemic attack and non-subarachnoid haemorrhage were proportionately more frequent in the 75 years and over age group. Serious secondary headache disorders, as defined above, were identified in 7% of patients overall, but were three times more common in older patients. In the ≥ 75 years age group, reported severity of pain was not associated with a serious secondary cause (p=0.5).

DISCUSSION

In this study, in contrast to younger patients, patients aged ≥75 years were more likely to report mild pain, new limb weakness or speech difficulties, and less frequently reported associated fever, nausea, vomiting and photophobia. They were more likely to have a serious cause for their headache diagnosed in the ED. They also had higher imaging utilisation and admission rates. The prevalence of headaches associated with serious underlying cause identified in this study (18%) is important because it supports and validates data from previous neurology literature.[6,13] Our results are also in keeping with prior literature in non-ED settings demonstrating lower incidence and prevalence of migraine with age.[4,5,7]

The high rate of CT scan in older patients with headache is noteworthy. While they will be in part due to higher prevalence of new neurological findings or confusion on examination, it may also reflect an awareness by clinicians that, as found in this study, about 1 in 5 older people presenting with headache will have a serious secondary cause. The high rate of serious secondary cause reinforces that clinicians should have a low threshold for investigation, especially neuroimaging.

As a group, older patients with headache presented with less severe pain and fewer associated general non-neurological symptoms. Severity of pain was not associated with identification of a serious secondary cause. Possible explanations include changes in disease prevalence with age (particularly the decreasing prevalence of migraine), immunosenescence, physiologic changes of ageing or underreporting and recording of symptoms.[7,21,22] Older adults are known to present atypically or with less severe symptoms for a variety of disease processes including myocardial infarction, urinary tract infection, intra-abdominal infection and traumatic intracranial haemorrhage.[23-26]

Previous findings in older patients with traumatic intracranial haemorrhage have parallels to our work on nontraumatic headache. Older patients presenting with traumatic intracranial

haemorrhage were shown to have a higher level of consciousness (based on Glasgow coma scale) compared to younger patients for a given anatomical severity of injury.[26] Some proposed reasons for this include increased intracranial capacity secondary to cerebral atrophy, differing progression of pathology and less obvious impact on higher cognitive function.[26] Certain clinical indicators of severe disease can be subtle and harder to detect in older patients, making them potentially more vulnerable to missed or delayed diagnosis. Further research exploring whether older patients with serious secondary causes of headache exhibit different clinical features than a younger cohort may warrant exploration.

Our study has strengths in its size and geographical variation. Our study has some limitations which should be considered when interpreting the data. While our study comprised a large number of patients with headache-related ED presentations from a range of countries, hospital sizes and medical systems, four of the ten countries accounted for approximately 85% of the presentations. This may in part reflect how communities use EDs. It is possible that some diagnoses are region dependent. In addition, access to and ordering of neuroimaging may vary between countries.[16,27] Data abstraction in this study was performed by local researchers at each site supported by a data dictionary but not formal training, which may have compromised the quality of the source data. Cross checking of data abstraction was not performed. We did not collect data about inclusion/exclusion response which may limit generalisability of our findings. Data collection forms were however standardised and piloted. While attempts were made to prospectively enrol patients and collect data, this was not feasible at all sites because of resource constraints; retrospective data entry may have further limited data quality and increased the proportion of missing data.[28] The final ED diagnosis was recorded based on a subjective clinical impression derived from information available at the point of ED discharge. Additional information later may have revealed an alternative pathological diagnosis. We did not collect data on functional baseline, or goals of care status which may have impacted decisions regarding diagnostic work-up in older patients and subsequent clinical impression at discharge. Despite the overall large numbers in the study, the range of diagnoses represented in this cohort has resulted in low absolute numbers for certain diagnoses. As such, generalisability is limited.

CONCLUSION:

In this study, patients aged ≥75 years were more likely than younger patients to report mild pain, new limb weakness or speech difficulties and less frequently reported associated fever, nausea, vomiting and photophobia. On examination, they were more likely to be confused and hard new neurological signs. Older patients with headache were more likely to have a

serious secondary cause for their headache identified in the ED. Imaging and management pathways should reflect these increased risks.

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Table 1: Patient Demographics

Variable	**Result (Total N=4536)**	**Age <75 years (4238, 93%)**	**Age ≥75 years (298, 7%)**	**Missing data (N)**	**P value**
Age (years, median, IQR)	41 (29-55)	39 (28-52)	81 (77-86)	0	N/A
Gender (male, N, %,)	1627, 36%	1518, 36%	109, 37%	1	0.002
Referral by a doctor (N, %)	788, 17%	722, 17%	66, 22%	0	0.02
Arrival by ambulance (N, %)	791, 17%	654, 15%	137, 46%	0	<0.001
Duration of symptoms (N, %)					
<24h	2060, 46%	1910, 46%	150, 51%	70	0.02*
1-3 days	1021, 23%	975, 23%	46, 15%		
>3 days	1385. 31%	1289, 31%	96, 33%		
Triage category (N, %)					
Immediate	77, 2%	66, 2%	11, 4%	0	<0.001*

Urgent	2294, 51%	2103, 50%	191, 64%		
Non-urgent	2165, 48%	2069, 49%	96, 32%		
Past medical history (N, %)					
Physician-diagnosed migraine	953, 21%	934, 22%	19, 6%	0	<0.001
Stroke/TIA	144, 3%	92, 2%	52, 17%	0	<0.001
Known cerebral malignancy-primary or secondary	44, 1%	43, 1%	1, 0.3%	0	0.3
Active non-cerebral malignancy	67, 1%	51, 1%	16, 5%	0	<0.001
Serious intracranial injury	48, 1%	41, 1%	7, 2%	0	0.1
Ventriculo-peritoneal shunt	42, 1%	40, 1%	2, 1%	0	0.68
Intracranial aneurysm without haemorrhage	38, 1%	27, 1%	11, 4%	0	0.001
Subarachnoid haemorrhage	19, 0.4%	16, 0.4%	3, 1%	0	0.2
Known vascular abnormality	18, 0.4%	16, 0.4%	2,1%	0	0.7
Chronic Medications (N, %)					
Opioids (excluding codeine)	115, 3%	104, 2%	11, 4%	0	0.1
Codeine preparations	64, 1%	56, 1%	8, 3%	0	0.7
Long acting anticoagulants	102, 2%	50, 1%	52, 17%	0	<0.001

* Omnibus Chi Square; IQR, interquartile range; N, number; TIA, transient ischaemic attack

Table 2: Clinical Symptoms

Clinical Symptoms (N, %)	**Total (N=4536)**	**Age <75 years** (N=4238)	**Age ≥75 years** (N=298)	**Missing data (N)**	**P value**
Onset of symptoms#				0	
Gradual	2486, 71%	2341, 71%	145, 67%		0.3*
Sudden/thunderclap (instant peak)	644, 18%	595, 18%	49, 23%		
Peak intensity <1 hour	366, 10%	344, 10%	22, 10%		
Unknown	1040 (23%)#	958 (23#%)#	82 (28%)#		
Location of headache#				0	
Generalised	2597, 67%	2429, 67%	168, 68%		0.4*
Unilateral	1290, 33%	1210, 33%	80, 32%		
Unclear	648 (14%)#	598 (14%)#	50 (17%)#		
Severity#				0	
Mild (pain score ≤3)	815, 21%	742, 20%	73, 31%		<0.001*
Moderate (pain score 4-7)	1869, 48%	1766, 48%	103, 44%		
Severe (pain score >7)	1235, 32%	1177, 32%	58, 25%		
Unclear	616 (14%)#	552 (13%)#	64 (21%)#		
Associated Symptoms					
Reported neck pain or stiffness	756, 17%	721, 17%	35, 12%	0	0.02
Nausea or vomiting	1844, 41%	1767, 42%	77, 26%	0	<0.001
Syncope/loss of consciousness	136, 3%	126, 3%	10, 3%	0	0.7
Reported photophobia	940, 21%	920, 22%	20, 7%	0	<0.001
New limb weakness (current/transient)	201, 4%	178, 4%	23, 8%	0	0.004
New limb paraesthesia (current/transient)	268, 6%	255, 6%	13, 4%	0	0.2
New speech difficulty (current/transient)	152, 3%	132, 3%	20, 7%	0	<0.001
New visual disturbance (current/transient)	600, 13%	560, 13%	40, 13%	0	0.9

Subjective fever or rigors	406, 9%	398, 9%	8, 3%	0	<0.001
Reported rash	56, 1%	50, 1%	6, 2%	0	0.3
Current or recent IV drug use	30, 1%	29, 1%	1, 0.3%	0	0.7
Worst headache ever	582, 13%	554, 13%	28, 9%	0	0.07
Head trauma within the last week	111, 2%	99, 2%	12, 4%	0	0.07

- For named categories reported as percent of total with a named category response. For unknown/unclear reported as percent of total. * Omnibus Chi Square; IV=intravenous

Table 3: Clinical Examination

Clinical examination	**Total (N=4536)** (N, %)	**Age <75 years (N=4238)** (N, %)	**Age ≥75 years (N=298)** (N, %)	**Missing data N, (N age <75 years, age≥75 years)**	**P value**
Vital signs					
Pulse rate >110 (N, %)	149, 3%	144, 3%	5, 2%	0	0.09
Systolic BP >160mmHg	540, 12%	485, 12%	116, 9%	63, 1% (60, 1%/3, 1%)	<0.001
Systolic BP <90mmHg	8, 0.2%	8, 0.2%	0		NS
Temperature >38C (N, %)	104, 3%	102, 3%	2, 1%	632, 14% (596, 14%/36, 12%)	0.07
Glasgow Coma Score (N, %)				537	
15	3921, 98%	3681, 98%	240, 93%	0	<0.001*

13-14	62, 2%	46, 1%	16, 6%		
10-12	8, 0.2%	6, 0.2%	2, 1%		
<10	8, 0.2%	7, 0.2%	1, 0.4%		
Any new neurological signs on examination	147, 3%	124, 3%	23, 8%	0	<0.001
Isolated speech deficit	10, 0.2%	8, 0.2%	2, 1%		
Isolated motor deficit	46, 1%	40, 1%	6, 2%		
Speech and motor deficit	7, 0.2%	5, 0.1%	2, 1%		
Incoordination/ cerebellar signs	24, 0.5%	20, 0.5%	4, 1%		
New visual defect on examination	97, 2%	87, 2%	10, 2%		
Other exam findings					
Rash on examination	70, 2%	63, 2%	7, 2%	0	0.2
Confusion on examination	68, 1%	52, 1%	16, 5%	0	<0.001
Meningism on examination	63, 1%	60, 1%	3, 1%	0	0.8

* Omnibus Chi Square; BP= blood pressure

Table 4: Diagnostics Imaging Investigations, Dispositions and Outcomes

	Total (N=4536)	**Age <75 years (N=4238)**	**Age ≥75 years (N=298)**	**Missing data (N)**	**P value**
Investigations	**(N, %)**	**(N, %)**	**(N, %)**		
Brain CT	1661, 37%	1471, 35%	190, 66%	0	<0.001
Normal	1360, 82%	1222, 83%	138, 73%		<0.001
SAH	31, 2%	27, 2%	3, 2%		NS
Other intracranial bleed	57, 3%	39, 3%	14, 7%		<0.001
Abscess	0	0	0		

Neoplasm	31, 2%	28, 2%	3, 2%		NS
MRI	151, 3%	138, 3%	13, 4%	**0**	0.3
Normal	89, 59%	84, 62%	5, 38%		0.1
Intracranial bleed	3, 2%	2, 1%	1, 8%		
Abscess	1, 1%	0	1, 8%		
Neoplasm	16, 11%	15, 11%	1, 8%		
Other (incl. nonacute changes)	42, 28%	37, 27%	5, 38%		
CT angiography	219, 5%	195, 5%	24, 8%	0	0.007
Normal	158, 72	141, 72%	17, 71%		
Aneurysm with bleed	19, 9%	18, 9%	1, 4%		0.35
Aneurysm without bleed	8, 4%	6, 3%	2, 8%		0.21
Lumbar puncture	171, 4%	169, 4%	2, 0.3%	0	0.001
CT plus MRI	114, 3%	104, 2%	10, 3%	0	0.9
CT plus CTA	196, 4%	175, 4%	21, 7%	0	0.02
Disposition	**(N, %)**	**(N, %)**	**(N, %)**	0	
Home from ED (including from ED observation unit)	3792, 84%	3606, 85%	186, 62%		<0.001*
Ward	633, 14%	537, 13%	96, 32%		
Critical care	33, 1%	31, 1%	2, 1%		
Transfer	63, 1%	51, 1%	12, 4%		
Died in ED	1, 0.02%	0	1, 0.3%		
Operating theatre	3, 0.07%	3, 0.07%	0		
Interventional radiology	1, 0.02%	0	1, 0.3%		
Unknown	10, 0.2%	10, 0.2%	0		
In hospital outcome	**(N, %, CI)**	**(N, %, CI)**	**(N, %, CI)**	**0**	
Mortality	11, 0.2%	7, 0.2%	4, 1%		0.07

* Omnibus Chi Square; CT = computed tomography; CTA = computed tomography angiogram; ED = Emergency department; MRI = magnetic resonance imaging; SAH = subarachnoid haemorrhage

Table 5: Final ED Diagnosis

ED Diagnosis	Total (N=4536)	Age <75 years (N=4238)	Age ≥75 years N=298)	P value (major selected)
Non-migraine primary headache (unspecified)	1598, 35%	1491, 35%	107, 36%	0.8
Migraine	1101, 24%	1088, 26%	13, 4%	<0.001
Tension headache	317, 7%	296, 7%	21, 7%	
Viral illness (non-meningitis)	204, 4%	199, 5%	5, 2%	
Sinusitis	141, 3%	139, 3%	2, 1%	
Post traumatic headache	76, 2%	70, 2%	6, 2%	
Musculoskeletal	72, 2%	66, 2%	6, 2%	
Cluster headache	71, 2%	71, 2%	0	
Stroke/ TIA	68, 1%	46, 1%	22, 7%	<0.001
Stroke*	50, 1%	33, 1%	17, 6%	
TIA	18, 0.4%	13, 0.3%	5, 2%	
Hypertension	64, 1%	51, 1%	13, 4%	<0.001
Hypertension crisis/urgency/malignant*	11, 0.2%	9, 0.2%	2, 1%	
Pregnancy-related hypertension*	5, 0.1%	5, 0.1%	0	
Hypertension-other	48, 1%	37, 1%	11, 4%	
Non SAH intracranial haemorrhage /haematoma*	57, 1%	41, 1%	16, 5%	<0.001
Subarachnoid haemorrhage*	44, 1%	39, 1%	5, 2%	
Neoplasm*	43, 1%	38, 1%	5, 2%	
Meningitis (all)	48, 1%	48, 1%	0	
Viral*	40, 1%	40, 1%	0	
Bacteria*	3, 0.07%	3, 0.07%	0	
Unknown*	5, 0.1%	5, 0.1%	0	
Trigeminal neuralgia/cranial neuralgia	34, 1%	26, 1%	8, 3%	
Non-cranial sepsis (e.g. pneumonia, UTI, tonsillitis etc)	29, 1%	28, 1%	1, 0.3%	
Idiopathic Intracranial hypertension*	27, 1%	26, 1%	1, 0.3%	
Vertigo/BPPV	23, 0.5%	18, 0.4%	5, 2%	
Post lumbar puncture headache	13, 0.3%	13, 0.3%	0	
Ventriculoperitoneal shunt issues*	12, 0.3%	12, 0.3%	0	
Temporal arteritis*	11, 0.2%	6, 0.1%	5, 2%	

Dental cause	10, 0.2%	10, 0.2%	0	
Anxiety/psychogenic	9, 0.2%	8, 0.2%	1, 0.3%	
Alcohol-related hangover	8, 0.2%	8, 0.2%	0	
Post coital headache	8, 0.2%	8, 0.2%	0	
Aneurysm/vascular malformation	8, 0.2%	8, 0.2%	0	
Toxicity	6, 0.1%	6, 0.1%	0	
Hyponatraemia	6, 0.1%	4, 0.09%	2, 1%	
Herpes zoster of head and neck	6, 0.1%	3, 0.07%	3, 1%	
Encephalitis*	6, 0.1%	5, 0.1%	1, 0.3%	
Seizure	6, 0.1%	6, 0.1%	0	
Vascular dissection*	4, 0.09%	4, 0.09%	0	
Hydrocephalus*	4, 0.09%	3, 0.07%	1, 0.3%	
Analgesia overuse syndrome	2, 0.04%	2, 0.05%	0	
Glaucoma	2, 0.04%	2, 0.05%	0	
Cerebral abscess*	1, 0.02%	1. 0.02%	0	
Other	157, 3%	134, 3%	23, 8%	
Unclear	240, 5%	214, 5%	26, 9%	
Serious secondary cause (marked *)	**323, 7.%**	**245, 6%**	**53, 18%**	**<0.001**

BPPV = benign paroxysmal positional vertigo; TIA = transient ischaemic attack; SAH = subarachnoid haemorrhage; UTI=urinary tract infection

Online appendix 1: Geographical Distribution

Distribution by country	**Total patients** (N, % study population)	**Patients Age ≥75 years** (N, % study population)	**Patients aged ≥75 years investigated with Brain CT** (N, % study population)	**Patients aged ≥75 years found to have a serious secondary cause of headache** (N, % study population)
Total	**4,536**	**298, 7%**	**190, 64%**	**53, 18%**
Australia	1777, 39%	150, 50%	91, 48%	26, 17%
Turkey	982, 22%	35, 12%	20, 11%	6. 17%
New Zealand	593, 13%	51, 17%	38, 20%	16, 31%
Singapore	579, 13%	22, 7%	18, 9%	2, 9%
United Kingdom	276, 6%	24, 8%	16, 8%	2, 8%
France	114, 3%	4, 1%	2, 1%	1, 25%
Belgium	70, 2%	2, 0.6%	1, 0.5%	0
Romania	69, 2%	4, 1%	0	0
Hong Kong	64, 1%	6, 2%	4, 2%	0
Israel	12, 0.3%	0	0	0

CT= computed tomography